AD-A139 744 THE MOSIS (MOS IMPLEMENTATION) SYSTEM (WHAT IT IS AND HOW TO USE IT)(U) UNIVERSITY OF SOUTHERN CALIFORNIA MARINA DEL REY INFORMATION S.. MAR 84 ISI/TM-84-128 1/1

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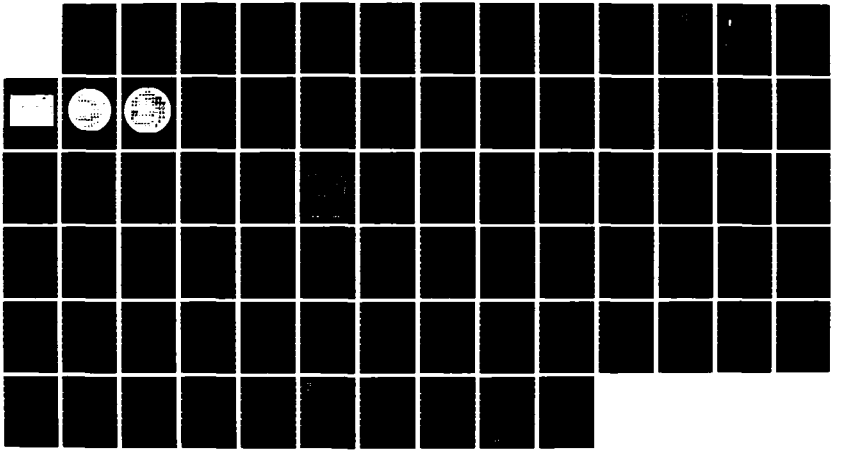

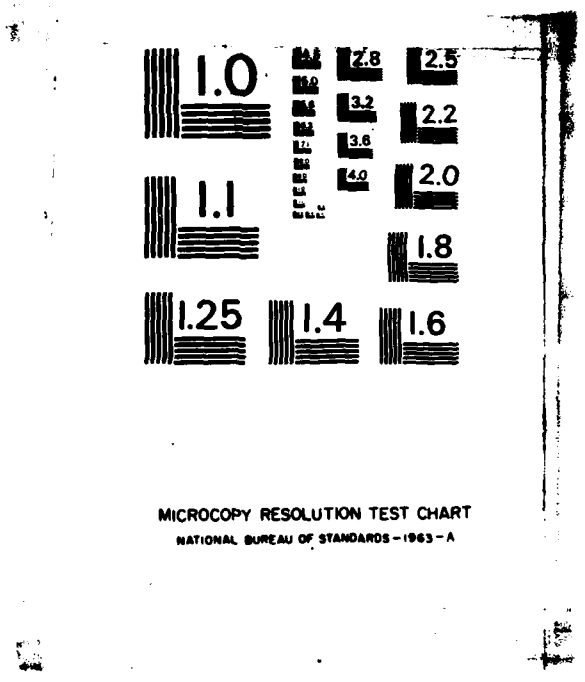
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ISI/TM-84-128
March 1984

University
of Southern
California

The MOSIS Project

The MOSIS System

(what it is and how to use it)

INFORMATION
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213/822-1511
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fabrication, foundry, MOSIS, integrated circuit, prototyping, silicon broker, VLSI

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

In over three years of operation at ISI, ARPA's MOS Implementation System (MOSIS) has met its initial design objectives. It has reduced the cost of VLSI prototyping, shortened turn-around time for VLSI prototyping, freed designers from fabrication idiocyncracies, and made design less dependent on specific fabrication lines.

This document includes step-by-step illustrations of information retrieval from MOSIS and of design submittals to MOSIS; the MOSIS user manual is also included.

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University
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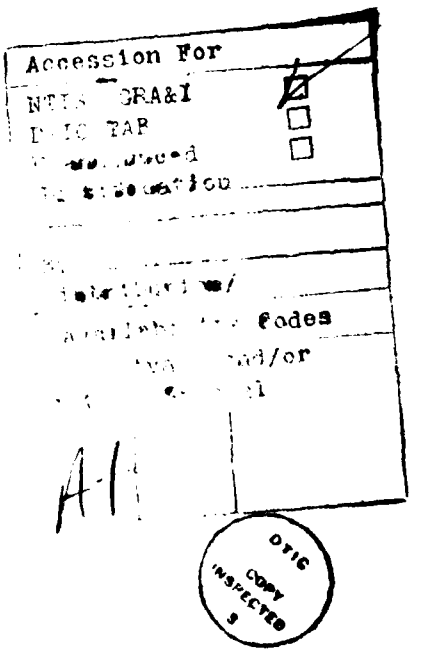

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Contents

The MOSIS System
(what it is and how to use it)

by

The MOSIS Project
USC / ISI
4676 Admiralty Way
Marina del Rey, CA 90292

(A) Purpose

The purpose of this document is to:

- provide a general description of the MOSIS system;
- list detailed instructions with examples of how to use MOSIS.

The MOSIS system provides online instructions to users. This document, however, is addressed to prospective new users and contains information on:

- what the service offers;
- how the service works;
- how to interact with MOSIS;
- how to become an authorized MOSIS user;
- how circuit designs are submitted, processed, and tracked.

This document includes step–by–step illustrations of information retrieval from MOSIS and step–by–step illustrations of design submittals to MOSIS.

The MOSIS user manual (as of 1 March 1984) is also included in this document; however, users should be aware that *only the online version of this manual is up–to–date to the time of its retrieval*, unlike offline documents (e.g., this manual) which are current only to the time of their printing. Instructions for obtaining online documentation via electronic mail are included in this document.

(B) What is MOSIS?

Under the sponsorship of the US Defense Advanced Research Projects Agency, the Information Sciences Institute (ISI) of the University of Southern California has been operating the MOS Implementation Service (MOSIS) for over three years. During this time, MOSIS has met its design objectives. It has:

- reduced the high cost of VLSI prototyping;
- shortened turnaround time for VLSI prototyping;
- freed designers from fabrication idiosyncracies;
- made design less dependent on specific fabrication lines.

MOSIS serves as the interface between designers of integrated circuits and the vendor base that fabricates the devices. By centralizing and automating the idiosyncratic requirements of fabrication vendors, MOSIS saves designers the enormous amount of time and energy they would otherwise expend in becoming familiar with vendor peculiarities.

MOSIS achieves cost reduction of one to two orders of magnitude by spreading the cost of fabrication over many projects submitted by designers from several universities and other research and development organizations.

The greatest impact of MOSIS is in the community it has created. The MOSIS community not only shares the fabrication services, but experience, cells, tools, software, and more. MOSIS now supports nMOS, CMOS/Bulk, CMOS/SOS, and Printed Circuit Board technologies. The rapid growth of both the MOSIS service and its user community proves that MOSIS is a very useful and important service to both the academic and the R&D communities.

(C) How Does MOSIS Work?

C.1. MOSIS and the User

MOSIS involves various aspects of multiproject wafer assembly, quality control, and interaction with industry, as shown in Figure 1.

The design of working chips requires more than just compiling artwork which adheres to the published geometric and electric design rules. It requires the application of various computation–intensive tools, such as SPICE and timing verification.

Designers use any available design tools to create artwork files that are sent to MOSIS via the ARPANET or other computer networks. MOSIS compiles a multiproject wafer and contracts with the semiconductor industry for mask making, wafer fabrication, and packaging. MOSIS then delivers packaged IC devices to the user. The user perceives MOSIS as a black box that accepts artwork files electronically and responds with packaged IC devices, as shown in Figure 2.

Though MOSIS may be instrumental in providing cells and design tools to the user, it is the sole responsibility of the user to see that the submitted patterns yield working designs. One may compare MOSIS to a publisher of conference proceedings compiled from papers submitted in "camera–ready" form, where the publisher's responsibility is to produce the exact image on the right kind of paper using the appropriate ink and binding — but not to address the spelling, grammar, syntax, ideas, or concepts of the various papers.

MOSIS provides a clean separation of responsibility for the "printing" of chips. The semiconductor manufacturer is responsible for the processing of the parts and must satisfy MOSIS's rigorous quality control. MOSIS is responsible to the user for the quality and timeliness of the fabrication. The user is responsible for the proper design of the parts and may use any design methods he finds appropriate for his needs.

It is quite common that very advanced and sophisticated chips fabricated by MOSIS work on "first–silicon". An example of this is Caltech's MOSAIC— this is an amazing accomplishment of the existing design tools. Unfortunately, this is done at a considerable cost; for example, it is estimated that Caltech's MOSAIC chip consumed over 1,000 CPU hours on various VAXes before it was submitted to MOSIS for fabrication.

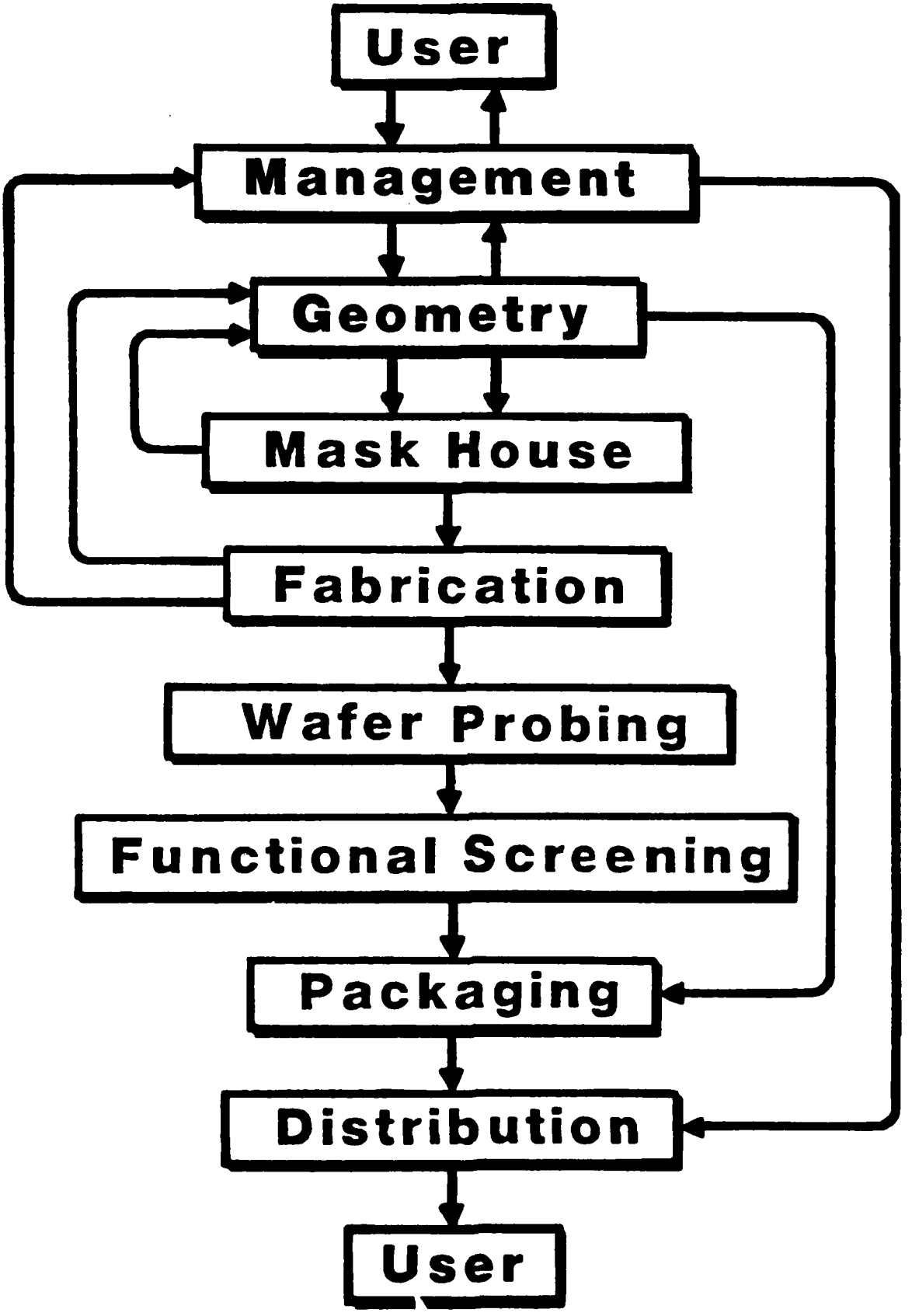


Figure 1. General flow of the MOSIS system

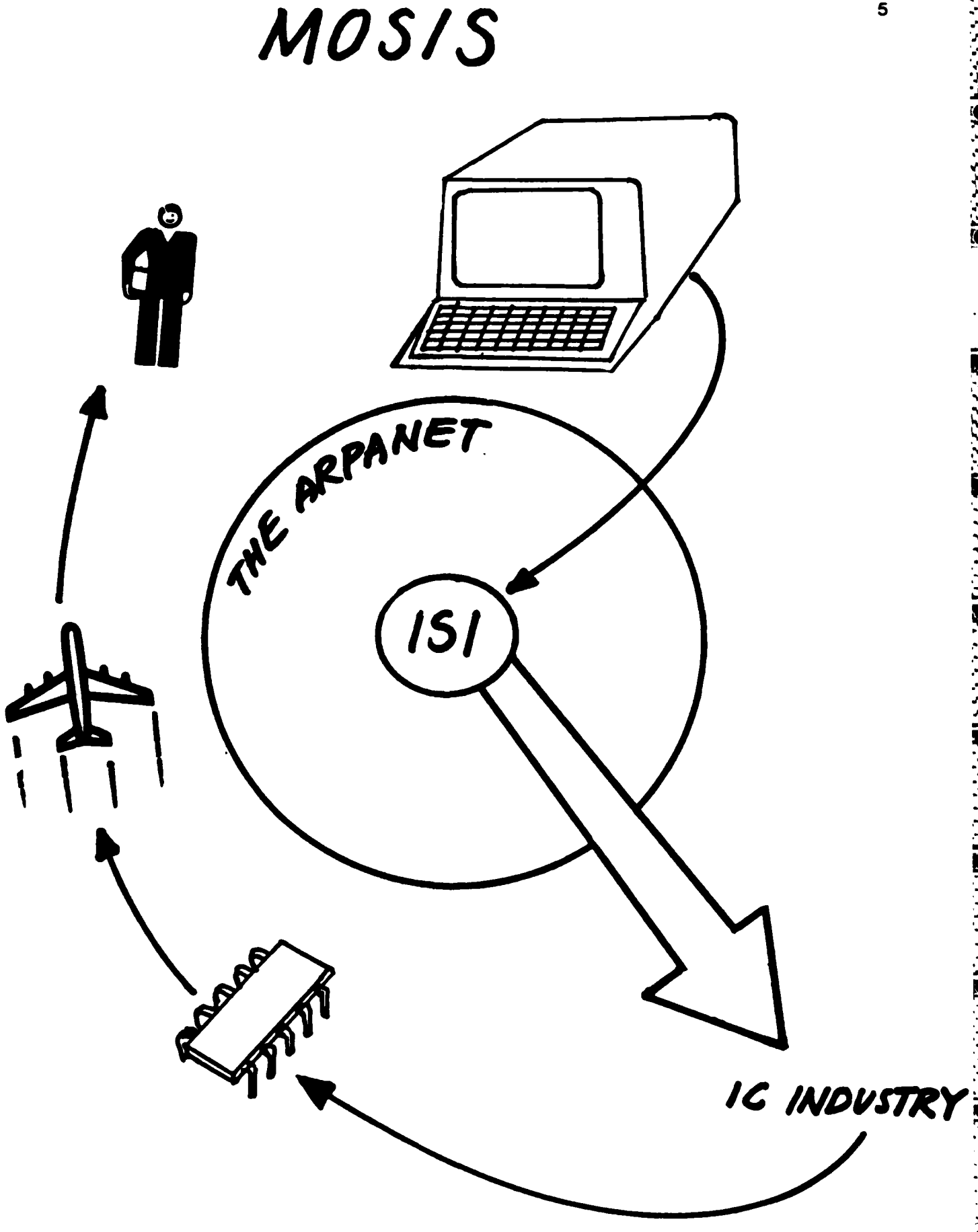


Figure 2: Interaction — user to MOSIS to user

C.2. Step by Step Processing

MOSIS usually aggregates several small projects submitted by the same organization into Multi-Project-Chips (MPCs), as shown in Figure 3, and the various chips of the same technology into Multi-Chip-Wafers (MCWs). It is common for MOSIS to have wafers with over 100 individual projects, as in the Orly run shown in Figure 4, and wafers with about 50 different die types of several different sizes as in the Nicole run shown in Figure 5.

MOSIS maintains strict quality control at each point of fabrication. After processing and grouping project data, MOSIS writes magnetic tapes for the tooling process. Typically, the tooling is a set of E-beam 1X masks. The tooling is delivered to the appropriate fabrication line, where it is checked to be within the QA-specification.

After fabrication, wafers are DC parametrically probed by the vendors using their Process Control Monitoring (PCM) devices. MOSIS then performs DC parametrical probing using its own set of test structures to extract SPICE parameters and to assure that the wafers indeed meet the MOSIS specifications. In addition to parametric measurement structures, MOSIS wafers contain test devices which evaluate the relative yield rate of individual conducting layers. Dies with random fault structures are probed during DC parametric testing to detect excessive frequency of faults in each of the conducting layers. Electrical tests are performed to reveal mask alignment errors and layer to layer oxide thickness.

After the DC probe testing is complete, the wafers are probed again to measure the relative yield of some large digital functions (canaries). These functions are usually static and dynamic memory and enable assessment of the lot yield relative to other lots from the same fabricator and from other fabricators.

Finally, one of the wafers (usually not passivated during fabrication) is examined with a scanning electron microscope to monitor the quality of metal step coverage and contact pits. If there is any indication of spiking in the contact pits, the wafer will be metal-stripped and examined further.

After testing is complete, MOSIS selects the wafers which best match the specifications. These wafers are diced into individual dies which are typically packaged in 28-, 40-, and 64-pin DIPs and 84-pin grid arrays. The bonding of chips into packages is performed according to either the standard pad frame bonding that the user specified or, for custom pad frames, custom bonding maps are produced by MOSIS, as shown in Figure I-4.

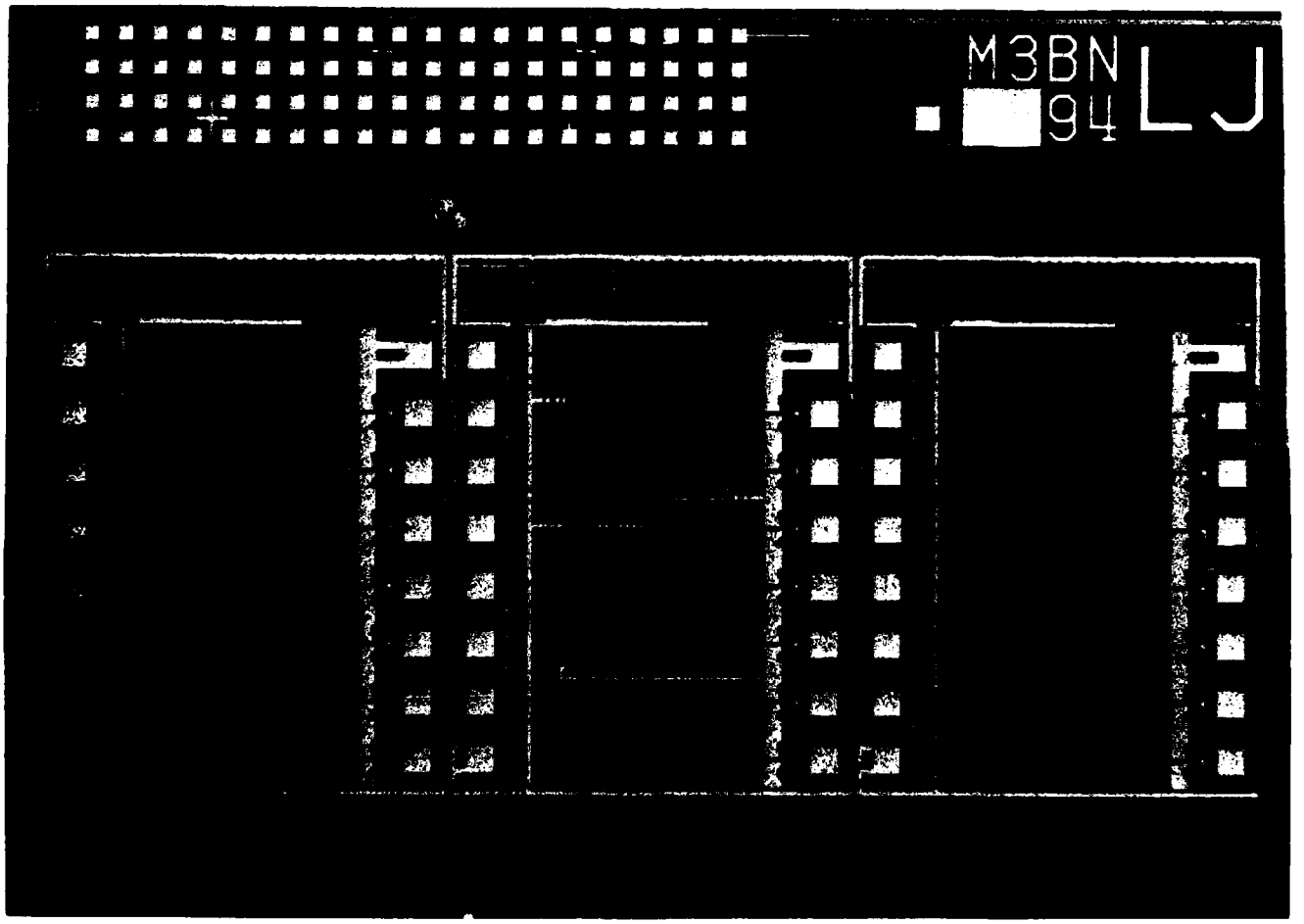


Figure 3: Multi-Project-Chip
(Used by permission of Kye Hedlund, UNC Chapel Hill)

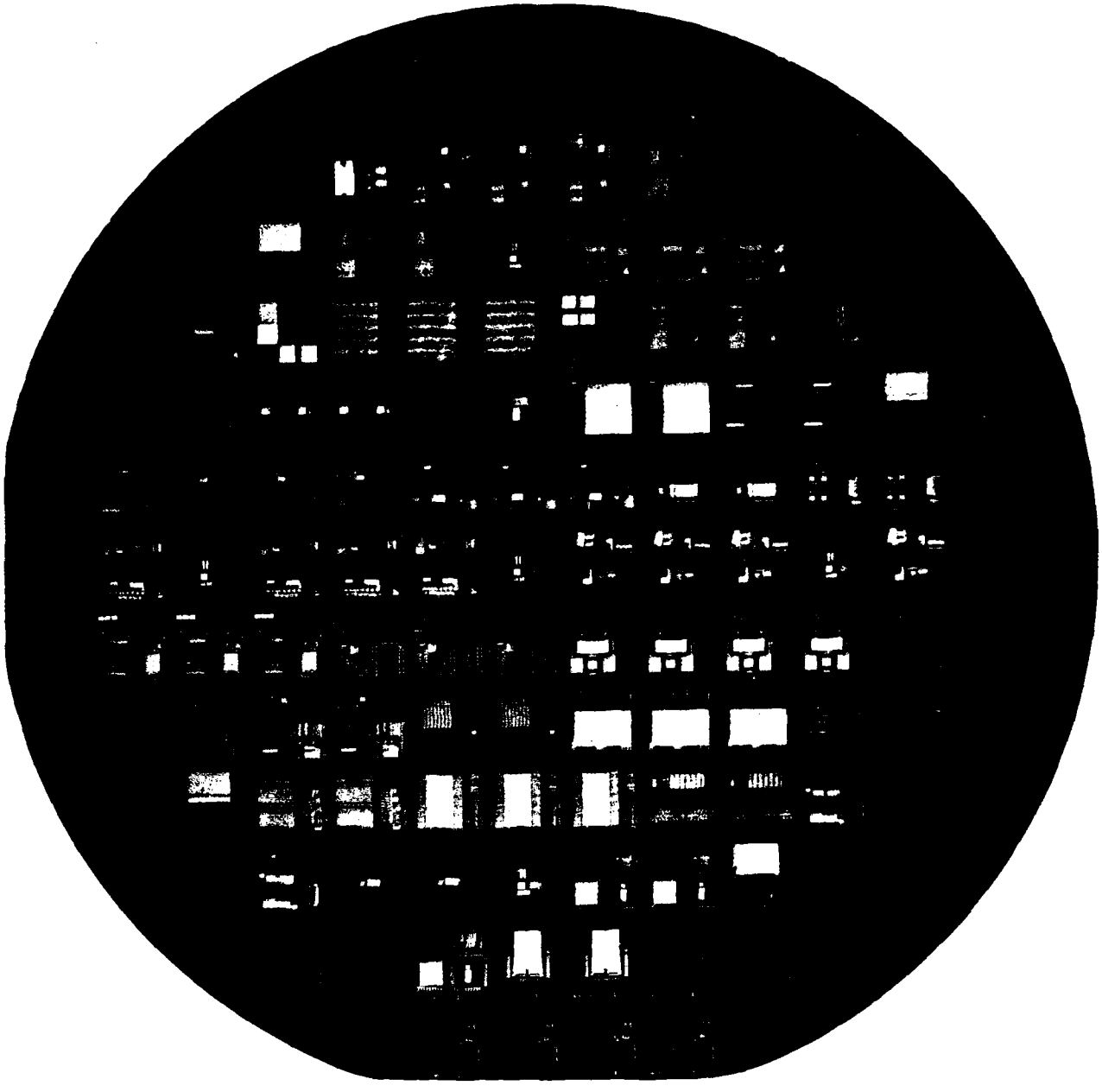


Figure 4: Multi-Chip-Wafer from the ORLY run, containing over 100 projects.

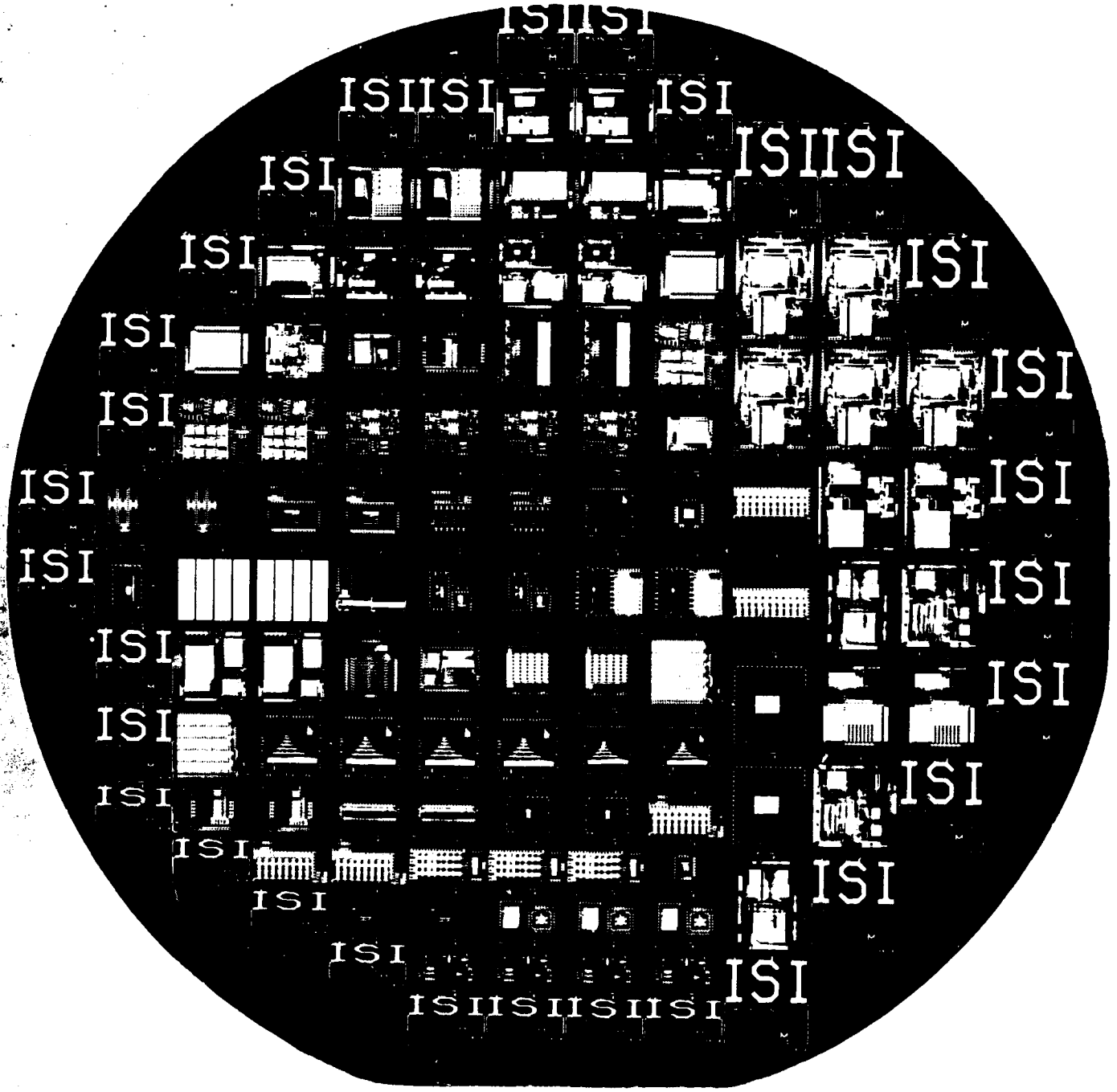


Figure 5: Multi-Chip-Wafer from the NICOLE run, containing Multi-Project-Chips of different types and sizes.

(D) Initiation to the MOSIS System

D.1. Access to MOSIS

MOSIS users must have access to either the ARPANET message system (directly or through some other network such as MILNET and CSNET) or to TELEMAIL.

MOSIS's electronic mail addresses are MOSIS@USC-ISIF.ARPA (in the ARPA Internet) and MOSIS/USCISI (in the TELEMAIL system). Users may communicate with MOSIS via either of these mail systems.

D.2. Meeting MOSIS

Users may request information from MOSIS on various topics, even before becoming authorized MOSIS users. A prospective user need only know the MOSIS address to receive instructions on retrieving MOSIS information. The user simply sends a message to MOSIS saying anything at all, as shown in Figure 6, and MOSIS responds with an introductory message, as shown in Figure 7. This response contains examples of the basic formats for various MOSIS information requests.

After receiving the MOSIS introduction, the user may request the list of topics in the MOSIS vocabulary, as shown in Figure 8. MOSIS will respond to this request with a list of topics on which information is available. Appendix II is the current list of information topics. A user may then request information on the topic "USER-MANUAL" as shown in Figure 9. MOSIS will provide the user manual by "return mail", like the one included in this document, except that it will be updated to the time of retrieval. This is a very long document, which may exceed the capacity of some mail systems. If this is the case, users should include in their information request the parameters listed in Section C.2.1 of the user manual (Appendix III).

A user may also request information on several topics at a time, as shown in Figure 10.

D.2.1. Completing a MOSIS Request

The most efficient way to signify an end to a MOSIS request message is by including as the last line "REQUEST: END". MOSIS will interpret this string as the completion of all requests in the message and will therefore begin processing the message immediately.

This request must be the last line of the entire request message. It is good form to include it in all request messages. It is mandatory to include it in all messages containing CIF-FRAGMENTs (see Section F.2) to ensure proper receipt of the CIF.

```
To: MOSIS@USC-ISIF.ARPA
From: Olive@Navy
Subject: First message

Hello out there!!!
Can anybody hear me???

------
```

Figure 6: A first message to MOSIS

```
To: Olive@Navy
From: MOSIS@USC-ISIF.ARPA
Subject: No Request found

Dear user:

This is ISI's MOS Implementation System (MOSIS).

We have received a message from you containing no recognizable
request for service.  If you wish to use the services of MOSIS,
kindly send to MOSIS@ISIF, or via TeleMail to MOSIS/USCISI, a
Net message containing the following lines:

                REQUEST: INFORMATION
                  TOPIC: GENERAL

MOSIS will send back a Net message containing information on how to
obtain authorization to use MOSIS.

If you need a MOSIS user manual, kindly send to MOSIS a message
containing the following lines:

                REQUEST: INFORMATION
                  TOPIC: USER-MANUAL

MOSIS will also supply information on other topics relating to
the MOSIS service.  To obtain the list of topics, kindly send
to MOSIS a message containing the following lines:

                REQUEST: INFORMATION
                  TOPIC: TOPICS

To bring some matter to the attention of the MOSIS team, kindly
send to MOSIS a message containing the following lines:

                REQUEST: ATTENTION

followed by the text you wish to bring to their attention.

                        Cheers,

                                              MOSIS
------
```

Figure 7: MOSIS response to first message

```
To: MOSIS@USC-ISIF.ARPA
From: Olive@Navy
Subject: Request for list of topics

        REQUEST: Information
        TOPIC:   TOPICS
        REQUEST: End

---
```

Figure 8: A message requesting MOSIS information topics

```
To: MOSIS@USC-ISIF.ARPA
From: Olive@Navy
Subject: Request for User Manual

        REQUEST: Information
        TOPIC:   User-Manual
        REQUEST: End

---
```

Figure 9: A message requesting the MOSIS user manual

```
To: MOSIS@USC-ISIF.ARPA
From: Olive@Navy
Subject: More than one topic

        REQUEST: Information
        Topic:   Topics
        topic:   SCHEDULE
        TOPIC:   technology
        Request: End

---
```

Figure 10: A message requesting information on three topics

(E) How to become an authorized MOSIS user

Authorization to use the MOSIS service is granted by either ARPA or NSF. Prospective users must justify their intended use of the service to their sponsoring agency.

E.1. DoD-sponsored Users

DoD-sponsored users should contact:

```
Paul Losleben
DARPA/IPTO
1400 Wilson Blvd.
Arlington, VA  22209

Net address: Losleben@USC-ISIA.ARPA
```

E.2. NSF-sponsored users

NSF-sponsored users NOT sponsored by DoD should contact:

```
Bernard Chern
NSF -- National Science Foundation
1800 G Street, NW
Washington, DC  20550

Net address: Chern@USC-ISIA.ARPA
```

In the process of seeking NSF approval, the user must have their NSF Principal Investigator complete NSF Form 1171 ("Authorization Request for Use of DARPA VLSI Fabrication Facility"), and return it for approval to the appropriate NSF program officer who monitors the grant.

E.3. Notification of Authorization

Applicants will be notified when they become authorized MOSIS users, and a MOSIS account will be established. The authorization process is handled entirely by DARPA, NSF, and MOSIS.

(F) After Authorization — Submitting Circuit Designs

F.1. MOSIS User Manual

The MOSIS user manual includes all requests and parameters required to submit a circuit design. All new users should request the online version of the user manual. Only the online version is guaranteed to be current.

Appendix III is the MOSIS user manual as of 1 March 1984.

F.2. Design Library

MOSIS maintains a library of commonly used circuits for the MOSIS community Currently, the library contains input–output pad circuits plus several PLA fragments and signal buffers that can be used within a PLA generator program within the user's CAD environment. It is highly recommended that users incorporate pad library cells in their designs because the pads are configured to provide assurance that there is sufficient pad–to–pad spacing and pad area for reliable wire bonding. Also, the pads are designed to provide a measure of electrostatic discharge protection for on–chip circuitry. Details for accessing the library are in Section C.2 of the user manual (Appendix III).

Contributions of circuitry to the library which may be of general interest to the community are encouraged.

F.3. Steps for Submittal

F.3.1. Intent to submit

Once authorized to use the MOSIS service, the user may submit designs for fabrication. The artwork for these designs must be in Caltech Intermediate Format (CIF). Before submitting the CIF, the user must send a message to MOSIS, informing MOSIS of his intent to submit a new project, as shown in Figure 11. MOSIS will acknowledge this intent to submit, as shown in Figure 12. The response from MOSIS will contain a project ID; all future messages to MOSIS regarding this project should reference both this ID and the project password (P–PASSWORD) as assigned by the user.

F.3.2. CIF verification

When the artwork is ready, the user submits it to MOSIS for preliminary checking, as shown in Figure 13. The syntax of the CIF is checked to verify that it was received correctly; in addition, MOSIS computes the project size and pad count (for a custom project frame) or pad layout (for a standard frame) and checks them against the values declared by the user. MOSIS does not check if each project complies with design rules — that is the responsibility of the designer. MOSIS informs the user that the CIF file is queued for validation, as shown in Figure 14.

After the CIF check, MOSIS will respond with either a pass–message, as shown in Figure 15, or a fail–message, as shown in Figure 16.

```
To: MOSIS@USC-ISIF.ARPA
From: Olive@Navy
Subject: Intent to submit new project

 REQUEST: NEW-PROJECT
   D-NAME:           Olive
   AFFILIATION:      Navy
   ACCOUNT:          78Q-675
   D-PASSWORD:       Popeye
   NET-ADDRESS:      Olive@Navy
   MAILING-ADDRESS:  Ms. O. Oyl
                     OP-9876
                     NAS Poseidon
                     Massachusetts 02177
   P-NAME:           VFFT
   P-PASSWORD:       Kaziboo
   DESCRIPTION:      This is a device to compute a Very Fast
                     Fourier Transform of sonar data which is the
                     key to the security of underwater rafts.
                     It works according to the principals described
                     in [OYL80] and in ......
   TECHNOLOGY:       NMOS/MC1
   LAMBDA:           2.0
   MIN-LAMBDA:       1.5
   MAX-LAMBDA:       2.5
   PADS:             24
 REQUEST: END

----
```

Figure 11: A message of intent to submit

```
To: Olive@Navy
From: MOSIS@USC-ISIF.ARPA
Subject: OK New-Project, 12345 VFFT

   ID:     12345
   P-Name: VFFT
   Status: New project; no valid CIF.

---
```

Figure 12: MOSIS response acknowledging new project

```
To: MOSIS@USC-ISIF.ARPA
From: Olive@Navy
Subject: Submit for CIF check

   REQUEST: SUBMIT
       ID:                12345
       P-PASSWORD:        Kaziboo
       SIZE:              2000 x 3000
       CIF-CHECKSUM:      931160  18320
       CIF:
               (LAP281B  --- VFFT.CIF);
               (symbol VFFT);
               DS 1 250 10;
               L ND;
               W 20 960,-50 960,100;
               B 60 500 1030,80;
               ......
               ......
               E
   REQUEST: END

---
```

Figure 13: A message requesting CIF check

```
To: Olive@Navy
From: MOSIS@USC-ISIF.ARPA
Subject: OK Submit, 12345 VFFT

  ID:      12345
  P-Name: VFFT
  Status: Queued for CIF check.


  Checksum: 931160 18320

---
```

Figure 14: MOSIS acceptance of CIF for check

```
To: Olive@Navy
From: MOSIS@USC-ISIF.ARPA
Subject: OK CIF-check, 12345 VFFT

   ID:      12345
   P-Name: VFFT
   Status: Valid CIF; NOT queued for fabrication.
   Size:    2000 x 3000 microns

---
```

Figure 15: MOSIS response: valid CIF

```
To: Olive@Navy
From: MOSIS@USC-ISIF.ARPA
Subject: Failed CIF-check, 12345 VFFT

   ID:      12345
   P-Name: VFFT
   Status: Failed CIF-check; no valid CIF.

   Error(s) found:

    ERROR: Could find only 23 of your 24 pads.

---
```

Figure 16: MOSIS response: failed CIF check

Any CIF that fails a CIF check is deleted from the MOSIS database. Therefore, any corrected or revised CIF should be submitted in complete form for checking as done originally. The Submit request may be used many times for correction and revision of CIF before the project is queued for fabrication.

Users who have difficulty submitting large CIF files through their mail systems may either fragment their CIF and submit each fragment separately, or ask MOSIS to use FTP for direct retrieval of the CIF file. Users communicating over noisy lines should use CIF-CHECKSUM to protect the integrity of design files. The user manual contains sections documenting CIF-FRAGMENT, CIF-CHECKSUM, and CIF-FTP-PATH.

F.3.3. Request for fabrication

When the CIF file is valid, the user may send MOSIS a Fabricate request to place the design in the fabrication queue, as shown in Figure 17. MOSIS will respond with acknowledgement of the Fabricate request, as shown in Figure 18.

```
To: MOSIS@USC-ISIF.ARPA
From: Olive@Navy
Subject: Request to fabricate

  REQUEST: FABRICATE
  ID:          12345
  P-PASSWORD: Kaziboo
  REQUEST: END

---
```

Figure 17: A message requesting fabrication of CIF

```
To: Olive@Navy
From: MOSIS@USC-ISIF.ARPA
Subject: OK Fabricate, 12345 VFFT

  ID:      12345
  P-Name: VFFT
  Status: Queued for fabrication.
  Size:   2000 x 3000 microns

---
```

Figure 18: MOSIS response - CIF queued for fabrication

F.3.4. Modifying requests

If a user needs to update the parameters of a project, cancel a request for fabrication, delete a CIF file, or withdraw a project from the MOSIS system entirely, the following sections may be referenced in the user manual (Appendix III):

C.6 The UPDATE Request
C.7 The DELETE-CIF Request
C.8 The CANCEL-FABRICATE Request
C.9 The CANCEL-PROJECT Request

F.3.5. Fabrication announcement

Closing dates for upcoming runs are posted in the run schedule file (available online from MOSIS, see Figure 10). After a run is closed, MOSIS creates the mask pattern tapes and sends them to the mask fabricator to begin the fabrication process. MOSIS informs the user of his project fabrication, as shown in Figure 19.

```
To: Olive@Navy
From: MOSIS@USC-ISIF.ARPA
Subject: Being fabricated: 12345 VFFT

  Status: Being fabricated.
  Fab-ID: M79HED1

The Fab-ID indicates on which die of run M79H (Honcho) the project
is fabricated.

From now on please obtain status and scheduling information
concerning this run by using the following MOSIS request:

                REQUEST: INFORMATION
                  TOPIC: M79H.STS
                REQUEST: END

                          Thank you very kindly,

                             The MOSIS Project
---
```

Figure 19: MOSIS informs user of project fabrication

The fabrication message to the user includes a new entity, a Fab-ID, that uniquely identifies this project on this particular fabrication run. A Fab-ID (the illustrated one is "M79HED1") consists of three parts: a four-character run ID ("M79H"), a two-letter die ID ("ED"), and a project number on the die ("1"); the project number ranges from one up to the number of projects on the given die. A run is also given a nickname ("Honcho") for easy reference (and for fun).

A run name is assigned by MOSIS to each distinct mask set that is used to fabricate a set of (identical) wafers. On occasion, MOSIS refabricates a die on another run. When this happens, the user receives

a second "being fabricated" message with a new Fab-ID, which usually differs from the first one only in the run name. Refabrication may occur for any of a number of reasons, most commonly that the MOSIS service has decided to back up a run with another run, usually with a different fabricator.

F.3.6. Status request

A user may request a status report on his project at any time during the fabrication process. The status of all of the projects on the same run is identical. Therefore, the preferred way of requesting status information is by requesting the status of the run rather than the status of the individual project, as shown in Figure 20.

```
To: MOSIS@USC-ISIF.ARPA
From: Olive@Navy
Subject: Project status request

   REQUEST: INFORMATION
     TOPIC: M79H.STS
   REQUEST: END

---
```

Figure 20: A message requesting status of project

F.3.7. Probing results request

When wafer fabrication is complete, wafers are first probed by the vendors to assure that their specifications have been met and, if so, are shipped to MOSIS. MOSIS then performs DC parametrical probing using its own set of test structures to assure that the wafers indeed meet the MOSIS specifications. The results of this probing are posted online. Users may retrieve probe results (parameters), as shown in Figure 21.

```
To: MOSIS@USC-ISIF.ARPA
From: Olive@Navy
Subject: Request for parameters

   REQUEST: Information
     TOPIC: M79H.PRM
   REQUEST: END

---
```

Figure 21: A message requesting parameters

F.3.8. Delivery of parts

When device packaging is complete, MOSIS sends the user bonded chips with information relating to the project. This information package consists of a cover letter, an acknowledgement of receipt of devices (to be signed and returned to the MOSIS Project via US Mail), a wire bonding diagram for custom frame projects (showing correspondence of the user's pads to the pins of the package), and a summary of the DC parametric measurements collected during wafer characterization by MOSIS before packaging. Appendix I is an example of the information package.

F.3.9. Submittal of reports — be specific

Finally, each user should provide MOSIS with a project report, as shown in Figure 22. Comprehensive reports should be sent as quickly as possible. In addition to its own quality control, MOSIS considers these reports for evaluation of vendors.

It is particularly important that all performance and yield data be reported separately for each fabrication of a project. Each report should clearly identify both the ID and Fab–ID of the project.

Reports should specify the die site location(s) of each project as well as the number of the wafer from which the devices were packaged; this information helps MOSIS locate fabrication defects. The site location of each die can be found in the top right-hand corner of the die when viewed under a microscrope; the wafer number is on each device label.

```
To: MOSIS@USC-ISIF.ARPA
From: Olive@Navy
Subject: REPORT on 12345 M79HED1 VFFT

  REQUEST: REPORT
       ID: 12345
       P-Name: VFFT
       Fab-ID: M79HED1
       P-P: Kaziboo
   REPORT:
            We received 25 bonded devices for this
            project. Only 23 of them were found to be
            fully operational at 25Mhz.

            Both defective dies have the same problem,
            and both came from site No. 43 on wafers
            #2 and #5.  Therefore, we suspect that this
            is a mask defect.
  REQUEST: END

---
```

Figure 22: A project report to MOSIS

(G) New and Future Services

G.1. Calma

The MOSIS Project will soon add Calma (GDS II Stream) Format as an alternative to CIF for the submission of artwork.

G.2. Functional Screening

In the near future, MOSIS will be able to do functional screening at wafer probe for users requiring large numbers of parts. The purpose of this screening will be to reduce the probability of packaging bad parts and to avoid performing exhaustive functional and performance testing. Users will be asked to specify the test code in terms of a language named SIEVE, which is now under review by the MOSIS community.

G.3. Library Expansion

The MOSIS library will soon contain a set of pads for CMOS/Bulk that will be designed to provide a very strong barrier against latch-up. For this latch-up barrier to be effective, it is necessary that the chip internal circuitry be completely enclosed by a well barrier. When I/O pads do not fully enclose the circuit area, a special barrier cell must be used to complete the barrier enclosure.

When a general interconnect service can be initiated, the library will be extended to include major logic functions, computational functions (multipliers, etc.), and memory.

G.4. Pad Router

In the near future, MOSIS will offer automatic placement and routing to pads for nMOS projects. Users will submit port information (i.e., ports, their position, layer, width, and pad requirement) in a predetermined format and will receive CIF corresponding to pad routing and pads which they can then merge with their geometry. Users always have the option to either accept or reject the MOSIS pad routing.

G.5. Standard Project Frames

The MOSIS service has introduced the option of using standard project frames for packaging: a rectangular area of a fixed size with a fixed set of bonding pad locations around the periphery of the rectangle. Figure 3 illustrates three standard frame projects.)

The circuitry in the remainder of the frame, the routing of pad connections, and the choice of pad types at each of the fixed locations are specified by the user. Details of this alternative to custom pad frames is found in Section H.1.2 of the MOSIS user manual (Appendix III).

Appendix I

Information Package

Figures I-1, I-2, I-3 and I-4 are examples of the transmittal paperwork sent to designers along with packaged parts. Please note that the probing results enclosed are also available online (see Section F.3.7) and that bonding diagrams are sent for custom frame projects only.

```
Ms. O. Oyl
OP-9876
NAS Poseidon
Massachusetts 02177

Dear M79H Participant:

Enclosed please find 25 packaged chips of your project:

            ID: 12345
        P-Name: VFFT
        Fab-ID: M79HED1

Attached is a bonding map for the project.  The die substrate,
indicated by an "X", is typically connected to pin 1, but may be
connected to a different pin or left unconnected.  Be sure to
check your bonding map.

Attached are the electrical parameters for the run.

The MOSIS group is very much interested in receiving feedback
concerning the projects, particularly regarding performance,
problems encountered, and if there are problems, what they are
(mask, fabrication, bonding, silicon defect, etc.).  Please send
your REPORT, either via netmail to MOSIS, or via US mail to:

     The MOSIS Project
     USC/Information Sciences Institute
     4676 Admiralty Way
     Marina del Rey, California 90292-6695

Kindly include in the subject line of your REPORT the Fab-ID and
P-NAME of your project.

                    Sincerely,

                        The MOSIS Project
```

Figure I-1: Project transmittal letter

Dear Project recipient:

Because of contract requirements, we must receive written acknowledgement of every project you receive from us.

Kindly acknowledge receipt of your project by signing and dating the form below, and return this form to us as soon as possible. The back of this form is preaddressed so that you may fold and seal it with our address on the outside ready for mailing.

Thank you for your cooperation and understanding.

Sincerely,

The MOSIS Project

PLEASE RETURN THIS FORM, WITH CORRECTIONS, IF ANY, TO:

The MOSIS Project
USC/Information Sciences Institute
4676 Admiralty Way
Marina del Rey, CA 90292-6695

I hereby acknowledge receipt of the below-described bonded project(s):

Quantity: 25
ID: 12345
P-Name: VFFT
Fab-ID: M79HED1

Signed: **********

Date: **********

Ms. O. Oyl
OP-9876
NAS Poseidon
Massachusetts 02177

Figure I-2: Device acknowledgement receipt

M79H ISI Accutest, NMOS/MC2, 4u, 3in, (level = 2)
10 wafers probed, total number of dies: 330

EXECUTIVE SUMMARY
DC Parametric Measurements

Tst	Count	Mean	Sigma	Sig/Mean		
54	329	0.949	0.02	2.31%	(V)	Vth Large Enh (Vbs=0)
65	329	-3.300	0.08	-2.37%	(V)	Vth Large Dep (Vbs=0)
19	329	6.191	0.22	3.63%	(um)	Metal Width Narrow
104	329	3.987	0.42	7.13%	(um)	Poly Width Narrow
107	328	3.973	0.15	3.78%	(um)	Diff Width Narrow
85	328	1.528	0.04	2.80%	(V)	Vinv (K8)
89	324	1.794	0.06	3.15%	(V)	Vinv (K4)
100	292	4.901	0.47	9.58%	(MHz)	Ring Freq 5.0V
10	330	14.478	5.34	36.90%	(uA)	Ids W2xL10 Dep Vd=5
11	330	5.940	3.61	60.79%	(uA)	Ids W2xL10 Dep Vd=5
12	329	39.584	2.30	5.80%	(uA)	Ids W4xL10 Dep Vd=5
13	329	22.966	1.81	7.87%	(uA)	Ids W4xL10 Dep Vd=5
14	330	95.068	10.02	10.54%	(uA)	Ids Min Dep Vd=5
15	330	57.445	8.02	13.96%	(uA)	Ids Min Dep Vd=5
16	323	0.008	0.00	15.42%	(uA)	Ids Min DepPas Vd=5
30	329	0.053	0.01	19.43%	(uA)	Ids L2xW10 Enh Vd=5.0
31	330	611.183	53.63	8.77%	(uA)	Ids L2xW10 Enh Vd=4.0
32	329	502.632	44.11	8.78%	(uA)	Ids L2xW10 Enh Vd=4.0
33	330	161.255	14.38	8.92%	(uA)	Ids L2xW10 Enh Vd=0.4
41	329	0.026	0.04	164.14%	(uA)	Ids L2xW10 Dep Vd=5
51	330	91.646	9.57	10.45%	(ua)	ids min enh vd=4.0
52	330	46.625	5.97	12.81%	(ua)	ids min enh vd=4.0
53	328	27.637	1.91	6.91%	(ua)	ids min enh vd=0.4

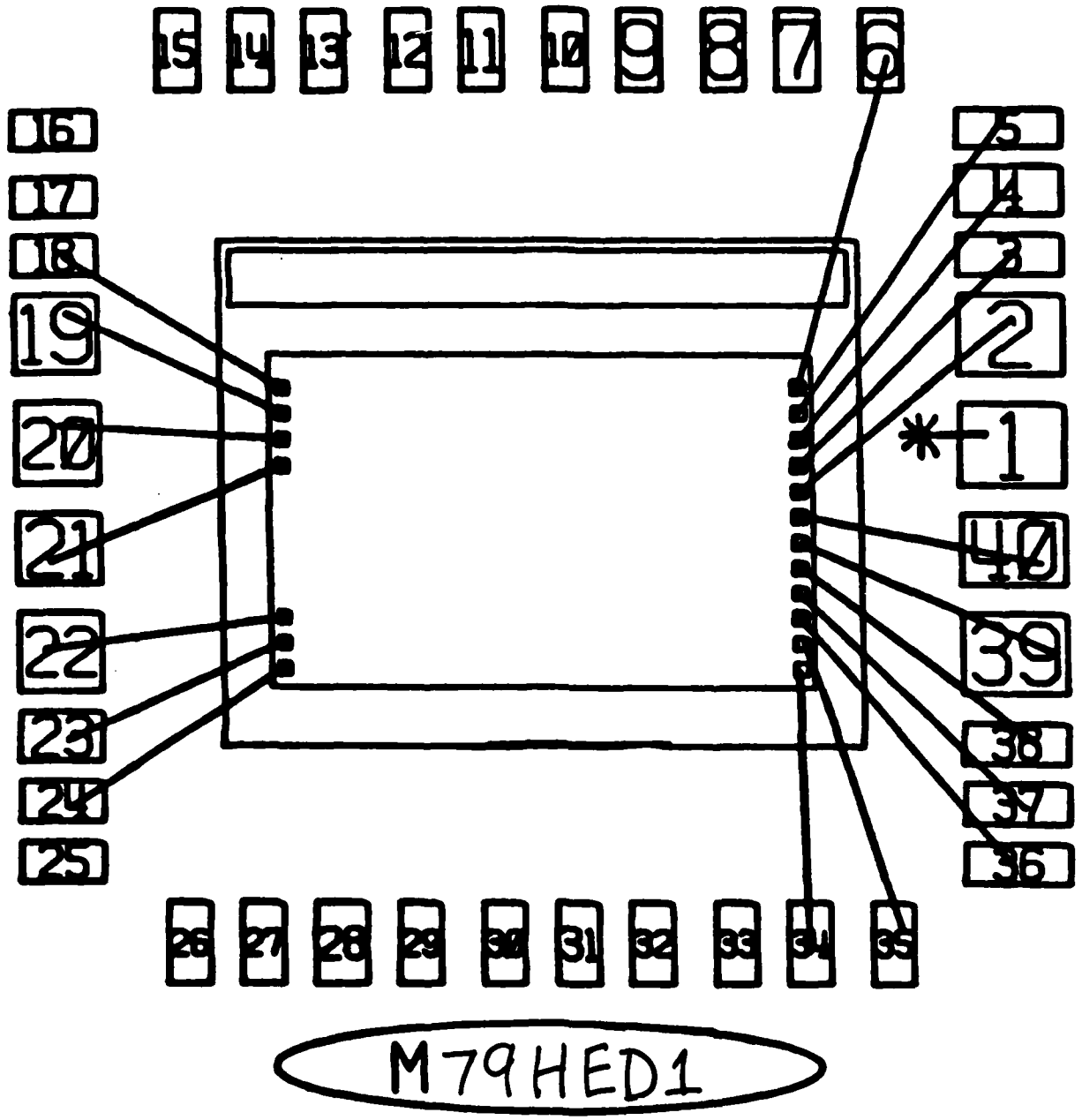
End of executive summary

COMPLETE TEST RESULTS

Tst	Count	Mean	Sigma	Sig/Mean		
1	330	-2.840	0.17	-5.99%	(V)	Vth Dep Length 10L
2	328	0.220	0.02	8.33%	(ua/v)	Slope Dep Width 2L
3	330	-3.076	0.07	-2.25%	(V)	Vth Dep Width 4L

...etc...

Figure I-3: DC parametric measurements of MOSIS run



PKG40

BOND 6 CHIPS

Figure I-4: Custom project frame bonding diagram

Appendix II

MOSIS Information Topic

Information about MOSIS is available on the following topics:

Topic name	Topic
TOPICS	This information.
GENERAL	Information on service provided, how to obtain authorization to use MOSIS.
USER-MANUAL	Details on the form of request messages to the MOSIS system.
TEMPLATES	A listing of the various MOSIS requests in the form of templates that may be filled in and sent to MOSIS as needed; especially handy for novice or casual users.
SCHEDULE	The schedule for open periods for submittal of designs to MOSIS, for fabrication, and other significant dates.
TECHNOLOGY	Summarizes the documentation on technology that MOSIS currently supports, including where to find design rule information for specific technologies.
OVERSIZE	Documentation on the MOSIS fabrication of oversize projects, including particularly when such projects will be fabbed.
QUANTITY-PARTS	Information on how to go about requesting large quantities of any one project.
STATUS	Status information about current MOSIS runs (i.e., those runs not completely distributed to MOSIS users).
ALL-RUNS	Status of all runs including those already completely distributed to their users.
NEWS	Information on recent changes to the MOSIS system.
ANNOUNCEMENTS	Copies of current MOSIS announcements; also sent to MOSIS liaisons.
DIRECTORY	A directory listing of the information files currently available through the INFORMATION request (this listing is updated daily).

Topic name	Topic
NMOSDR	The NMOS process design rules which MOSIS supports, including buried contact rules (similar files exist for other technologies; consult TOPIC:TECHNOLOGY for details).
CB3UDR.CIF	The CMOS–bulk 3–micron design rules, as plottable CIF (the prose description is presently available only in hard–copy form, available via an ATTENTION request).
run.STS	The status of the run named "run" (the name of the run for a particular fabricated device is the first four characters of its "Fab–ID").
run.PRM	The electrical parameters for the run named "run."
LIBRARY	Introductory information on the MOSIS cell library.

To obtain information about MOSIS, send a message via ARPANET to MOSIS@USC–ISI, or via TELEMAIL to MOSIS/USCISI, which includes the following lines:

```
REQUEST:    INFORMATION
TOPIC:      topic name
REQUEST:    END
```

where "topic name" is one of the names given above. MOSIS will reply to the message with information on the topic requested.

Appendix III

The MOSIS Project
USC/ISI

Major revision: 1 March 1984

MOSIS
USER MANUAL

(A) Overview: Interaction with MOSIS

All communication between users and MOSIS is carried out by net messages, either over the ARPANET system or TELEMAIL.

Typically, an authorized user first requests to submit a project for fabrication by sending the NEW-PROJECT message to MOSIS.

Upon acceptance of a project, MOSIS assigns a unique identification to it and communicates this ID to the user by a net message.

After receiving the ID, the designer uses the FABRICATE message to submit a CIF file to MOSIS for fabrication.

If the user wants only to check the validity of the CIF file, he may submit it for CIF check by using the SUBMIT message. Once he gets the results of this check, he may decide to either fabricate the project or delete the CIF file.

The FABRICATE message is used to request fabrication. The DELETE-CIF message is used to delete the CIF file without cancelling the project.

After deleting the CIF file, the user may submit a new design by again using either the SUBMIT (or FABRICATE) message.

After the project is submitted for fabrication, it is incorporated into queues.

If, after issuing the FABRICATE message, the user decides to cancel the fabrication, he may send the CANCEL-FABRICATE message; however, after a certain stage it is too late to stop the fabrication process.

If at any time the user wants to withdraw his project, the CANCEL-PROJECT message is used.

In addition to the above messages, there are also messages for requesting information about MOSIS, the status of projects, changing parameters, and more. All of these are described in this document.

Each message to MOSIS carries various parameters which are described in Section D, "REQUESTS AND PARAMETERS".

(B) Administration

B.1. Access Control, Authentication, and Accounting

There are several features for controlling user access to MOSIS services.

Access control is based on information entered into the MOSIS Authentication Data Base (ADB) by the MOSIS staff (rather than by users via net messages).

This information contains the list of designers authorized to use MOSIS services and includes their affiliation, individual passwords, and the designation of the account to be charged for each designer.

The use of passwords is similar to the use of passwords in conventional time-sharing systems. The designer password (D-PASSWORD) is distinguished from the project password (P-PASSWORD) as described later in this document.

A designer may have more than one account, with unique passwords for each.

In order to accept a user, MOSIS must have in its ADB the exact combination of the AFFILIATION, ACCOUNT, designer-name (D-NAME), and designer-password (D-PASSWORD).

The ACCOUNT is always treated as the extension of the AFFILIATION. Hence, "VLSI" of ISI and "VLSI" of MIT are different accounts. The actual accounts are defined by both the AFFILIATION and the ACCOUNT fields.

In addition to the above parameters, a designer must assign a password to each of his projects (P-PASSWORD). Hence a designer may invite a colleague to work on a particular project and be able to give him access to that project only.

To submit a project to MOSIS, the user must first issue an initial NEW-PROJECT message with his name (D-NAME), affiliation, designer-password (D-PASSWORD), and account designation. In addition, he must assign this particular project a project-name (P-NAME) and a project-password (P-PASSWORD) of his choice.

In all future communications about this project, the user must use both the P-PASSWORD and the ID (assigned by MOSIS).

B.2. Budget Control and Other Organizational Issues

The following has not yet been implemented

MOSIS as described above models the designers as belonging to a space which is organized only by their affiliations and accounts.

MOSIS will, at some future time, issue charges for most of its operations. Neither the charging units nor the charging policy have yet been defined.

The Authentication Data Base (ADB) will be augmented to include budget information for each account and each (AFFILIATION,ACCOUNT,D-NAME,D-PASSWORD) quadruplet.

Each MOSIS charge will be applied against both the designer's budget and the account's budget. MOSIS will not perform operations which result in overspending of these budgets.

The administrator of an account may "oversell" it by assigning to his designers budgets that total more than the entire budget of the account. This allows flexibility as long as the average project size does not exceed the expected one; however, this overbooking may be abused by prolific designers who share the account.

Passwords will also be assigned to both organizations (ORG-PASSWORD) and accounts (ACC-PASSWORD). The administrator of the organizations (i.e., "affiliations") and accounts must use them in order to obtain the accounting information regarding the projects that are charged to them.

The format of requests for accounting information has not yet been defined.

Please note that the ORG-PASSWORD and ACC-PASSWORD allow access to the accounting information regarding individual projects but not to the technical data (e.g., CIF). Also, individual designers will be able to get the accounting information for their projects by using certain requests.

(C) Requests to MOSIS

The following are detailed descriptions of MOSIS requests, including MOSIS actions and responses.

C.1. The INFORMATION Request

This request asks MOSIS for information on specific topic(s); e.g., how to make requests or how to retrieve schedules. MOSIS will respond with information on that topic or, if there is none, with a message describing the topics for which information is available.

The information request is specified by the TOPIC parameter. Several TOPIC parameters may be included in one REQUEST. This request may also include the ATTENTION, BYTE-LIMIT, or LINE-LIMIT parameters. All other parameters will be ignored.

- The topic "GENERAL" will retrieve information on how to become a MOSIS user.
- The topic "TOPICS" will retrieve a list of all topics on which information is available.
- The topic "MANUAL" will retrieve this document.
- The topic "SCHEDULE" will retrieve the current MOSIS run schedule.
- The topic "TECHNOLOGY" will retrieve information on technologies supported by MOSIS.
- The topic "NEWS" will retrieve information on recent changes to the MOSIS service.
- The topic "XXXXXX.YYY" will retrieve the file having that name, if any, from the MOSIS information service.

C.2. The LIBRARY Request

This request asks for information from the MOSIS library and may be used to retrieve information on the use of the library, the availability of designs in the library, and how to retrieve particular designs from the library. The specific request is specified by the TOPIC parameter.

Please note that this request may include the TOPIC parameter (which may be repeated for several topics) or the ATTENTION, BYTE-LIMIT, or LINE-LIMIT parameters. All other parameters will be ignored. The topic "LIBINFO" will retrieve information on using the MOSIS library. The LIBINFO file will supply information on the meaning of various files and extensions.

The topic "CATALOG" will retrieve names of all files which are available in the library. The CATALOG will supply information on various available designs and will point to the appropriate name, XXXXXX.YYY. The topic "XXXXXX.YYY" will retrieve the file having that name, if any.

C.2.1. Mail size limits

For the convenience of users whose host machines enforce particular limits on the size of incoming mail, MOSIS accepts, in INFORMATION and LIBRARY requests, two parameters: "BYTE-LIMIT" and "LINE-LIMIT". MOSIS interprets these two parameters as limits on the number of bytes and number of lines, respectively, in the body of the message(s) that MOSIS sends back to the user requesting the information or library file(s). Any information or library file that is larger than one or the other of the user-specified limit(s) will be sent to the user in as many messages as required. The MOSIS user may specify either or both limits in order to meet host machine requirements.

Please note that these are REQUEST parameters (NOT message header parameters) and must appear WITHIN each request (i.e., following the "REQUEST:" line). An example:

```
REQUEST:      INFORMATION
TOPIC:        CB3UDR.CIF
BYTE-LIMIT:    10000
REQUEST:      END
```

MOSIS uses these limits for its own text without taking into account the "message header" lines required for network mail; users whose host machines' limits include message header lines should specify to MOSIS limits that are at least 500 bytes and 10 lines smaller than their host-enforced limits.

C.3. The NEW-PROJECT Request

This is the first request a user makes to MOSIS. It establishes a proposed project, requests a project ID from MOSIS, tells MOSIS who is proposing the project, and specifies some of the expected parameters of the final project design.

MOSIS will acknowledge this request with a message giving the system-assigned ID for the project. This ID must be used in all future requests to MOSIS concerning the project.

In this request the designer has to identify himself by providing his affiliation, his name (D-NAME), his password (D-PASSWORD), and his account. MOSIS compares these parameters with the ones in its access table and, if an exact match is found, this project is accepted and an identification (ID) is issued for it. The message must also include both a net address(es) to which MOSIS should direct all of its messages about this project and a mailing address to which any artifacts (e.g., fabricated devices) should be mailed.

This message must also include a password (P-PASSWORD), a short name (P-NAME), and a description of the project. The designer may assign any random password to each of his projects. No

messages about this project will be accepted by MOSIS unless they contain both the ID as assigned by MOSIS and the password as assigned by the designer.

Several other optional parameters may be incorporated in this message. These include packaging parameters for the project and the value of lambda used in the project's CIF file. In addition, as in most requests, comments may be added and manual attention, special handling, and bonding instructions may be requested.

Most of the parameters specified in this message may be modified later by redefining them. The ones which cannot be changed through messages in the lifetime of the particular project are the designer's affiliation, name (D-NAME) and account, passwords (D-PASSWORD and P-PASSWORD), and mailing address - these can only be modified manually by the MOSIS crew. These parameters are designated with an asterisk "*" in the table of required parameters in Section D.3 in this document.

C.4. The SUBMIT Request

This request is used for submitting a CIF file to MOSIS. It implicitly asks MOSIS to perform a CIF validation check, to compute the size of the project (aka "MBB"), and to count the pads. It may be issued only after the project has been accepted by MOSIS and assigned an ID. This request must always include the ID of the project and its password (P-PASSWORD). It must also contain the size and the technology of the project, unless these were specified earlier.

Optional parameters for this request are the name of the project (P-NAME), project description, designer's net address, value of lambda, and packaging parameters. These parameters are either new entries to the MOSIS data base or updates to previously supplied parameters. In addition, as in most requests, comments may be added and manual attention, special handling and bonding instructions may be requested.

If all parameters needed for this request are present in satisfactory form, MOSIS will accept the CIF specification for validation check and will send an initial acknowledgment to the designer's net address. MOSIS will then place the CIF specification in a queue of CIF designs for validation check at a later time.

The CIF may be specified either directly in the message or by means of a CIF-FTP-PATH. CIF may also be sent in fragments in several messages. Please see Sections F and G in this document for details.

After performing the CIF check, MOSIS will send a second message detailing (1) CIF errors and/or warnings, if any, and (2) the actual (computed) size of the project. If MOSIS finds this CIF file acceptable, it keeps the file and notifies the designer via net mail. However, if errors are found, including CIF errors, standard frame mismatch, size mismatch, or insufficient number of bonding pads compared to the specification, MOSIS deletes the CIF file and notifies the designer via net mail.

Size mismatch is a gross mismatch between the project size supplied by the designer (in the SIZE parameter) or implied by the standard frame and the one computed by the MOSIS CIF check. A gross mismatch is an error greater than some epsilon in either the horizontal or the vertical dimension of the project (the value of epsilon is specified in the "Technology" information document). There is one exception: if the size estimate with dimensions transposed is within epsilon of the actual project size in either dimension, then there is no size mismatch.

For a custom frame project with a specified pad count, if the user specifies that there are more pads than MOSIS finds, MOSIS will reject the CIF. If the user specifies that there are fewer pads than MOSIS finds, MOSIS will issue a warning to the user.

When MOSIS receives a SUBMIT request for a project which already has a valid CIF file, the old CIF file is deleted and replaced with the new one. If the new file is not found valid, then it is deleted too, leaving the project without a valid CIF file. A valid CIF file is a file without fatal CIF size or pad errors, although it may contain other errors such as logic errors or design rule violations.

Please note that only error-free CIF files are retained by MOSIS; a project may have either a valid CIF file or no CIF file at all.

MOSIS considers all valid CIF files ready for fabrication and expects a subsequent FABRICATE request to follow shortly. MOSIS will delete a CIF file when a fabrication request for that file has not been received within a certain time period. It is possible to include the SUBMIT request in the FABRICATE request, as described below.

C.5. The FABRICATE Request

Typically, this is the final request the user makes concerning any particular design. It specifies that the user is satisfied with the design and is willing to have it fabricated in silicon according to the CIF file contained in either the last SUBMIT request or this current FABRICATE request. This request places the project in a queue of projects awaiting fabrication for the specified TECHNOLOGY. Thus, the sooner this request comes in, the sooner the project will be fabricated. The ID and P-PASSWORD

are mandatory parameters of this request. Many other parameters are optional for this request. In addition, as in most requests, comments may be added and manual attention, special handling, and bonding instructions may be requested.

As with the SUBMIT request, MOSIS acknowledges the receipt of the CIF in the first response message and supplies details of the CIF check in the second response message. MOSIS will send additional messages as necessary detailing various aspects of the fabrication process (e.g., expected date of completion of fabrication). After a successful FABRICATE request no further SUBMIT or FABRICATE requests may be issued for this project unless a CANCEL-FABRICATE request has been issued and accepted beforehand.

C.5.1. Changing the scale of designs

When a run is assembled (say, for lambda equal to 2.0 micron) and there are pending projects with other values of lambda, projects with larger values of lambda (say 2.5 microns) may be included in the run after being scaled down (by 2.0/2.5 here) if their MIN-LAMBDA is set to 2.0 microns or less. Otherwise, they may be included without any scale change, if there is enough room for them.

Projects with lower values of lambda (say 1.5 microns) would be included only after scaling them up (by 2.0/1.5 here), only if their MAX-LAMBDA was specifically used to allow that (here by setting it to be at least 2.0).

Please note that whenever the designer allows a change of scale it is his responsibility that the scaled design is functional from both electrical and mechanical (e.g., pad spacing) points of view. Hence, if a downscaling is allowed (by giving MIN-LAMBDA < LAMBDA) then the given pads must be oversized. If MIN-LAMBDA and/or MAX-LAMBDA are not specified, they assume the same value as LAMBDA.

The fabrication of the project will be performed only if: there is a valid CIF file (which could be submitted either within this request or by a previous SUBMIT request); the value of lambda for the project is specified; and all the required parameters are provided.

C.6. The UPDATE Request

This request asks MOSIS to change one or more parameters pertaining to a project.

The project ID and password (P-PASSWORD) are mandatory for this request. The optional parameters for this request are the name of the project (P-NAME), the description, the net-address, the phone number of the designer(s), the value of lambda, MIN-LAMBDA, MAX-LAMBDA, and the number of pads. In addition, as in other requests, comments may be added and manual attention, special handling, and bonding instructions may be requested.

C.7. The DELETE-CIF Request

This is a request to delete a CIF file which has previously been submitted and accepted. It may be issued at any time after the CIF file is accepted, but not after fabrication is requested.

MOSIS will respond to this request with a message notifying that the CIF file has been deleted. When the CIF file is deleted the size parameter of the project is set to zero, but no other parameter is changed. Hence, any submission of a CIF file must always include the size. The project ID and password (P-PASSWORD) are mandatory for this request. In addition, as in most requests, comments may be added and manual attention, special handling, and bonding instructions may be requested.

C.8. The CANCEL-FABRICATE Request

This request will withdraw a previous request to fabricate a project. It also implies the deletion of the CIF file. It does not cause the project itself to be withdrawn from MOSIS. This request should be used for correcting and resubmitting CIF. CIF corrections should always be made as soon as possible.

If fatal design errors are found by the designer, MOSIS appreciates a cancellation request as soon as possible, even if fabrication is already in progress, in order to avoid the expensive bonding of projects which are known to have problems. If a user submits this request when fabrication is already in progress, MOSIS will reply with a message notifying whether the fabrication is actually cancelled. If the fabrication is actually cancelled and the user wishes to fabricate a new version of the project, he must either submit a new CIF file for future fabrication or issue a new NEW-PROJECT request.

The project ID and password (P-PASSWORD) are mandatory for this request. Again, comments may be added and manual attention, special handling, and bonding instructions may be requested.

C.9. The CANCEL-PROJECT Request

This request asks MOSIS to cancel the project (i.e., to delete the design and all other data concerning the project) from the MOSIS system. The user has then completely withdrawn the project from MOSIS. MOSIS appreciates cancellation requests ASAP, even if fabrication is already in progress, in order to avoid the expensive bonding of projects which are known to have problems.

If a user submits this request when fabrication is already in progress, MOSIS will respond with a message describing any action taken on the request.

The project ID and password (P-PASSWORD) are mandatory for this request. In addition, comments may be added.

C.10. The STATUS Request

This request asks MOSIS to describe the status of a project. MOSIS will respond with estimated dates for fabrication and distribution of the project.

The project ID is mandatory for this request. Again, comments may be added and manual attention, special handling, and bonding instructions may be requested.

C.11. The REPORT Request

This request is used to supply feedback on previously fabricated devices to the MOSIS project. Reports help MOSIS evaluate fabrication vendors and their processes.

The project ID and password (P-PASSWORD) are mandatory for this request; however, the project name (P-NAME) and/or Fab-ID should be added. These parameters are to be followed by the parameter REPORT. The report may use as many lines of text as needed. The inclusion of the Fab-ID is especially useful to MOSIS in the event that the project is fabricated on more than one run.

Several reports on various projects may be submitted in one message. Several reports on one project may be submitted in one message.

C.12. The ATTENTION Request

This request asks MOSIS to bring something to the attention of the MOSIS team. The request may contain arbitrary text; no parameters (not even COMMENT) are recognized. MOSIS will respond with an acknowledgment and will forward the entire request to the MOSIS team for further consideration.

C.13. The END Request

This request marks the end of requests in a message. All text following this request is ignored by MOSIS.

(D) Requests and Parameters

A MOSIS service request is a network message in a special format. Each message to MOSIS may contain several REQUESTs, each of which may contain several parameters that are arguments for the requests. To begin a request, one includes in a message a line with the keyword "REQUEST:" followed by the name of the request.

Following the request line is some number (depending on the request) of parameter specification lines. Typically, one parameter is specified per line. Each parameter specification reads:

<par-name>: <par-spec> where <par-name>: is the name of some parameter, and <par-spec> is the specification of the parameter. Exceptions to this are detailed in the individual request and parameter descriptions.

Following the parameter specifications is either another request or the "END" request, which signals the end of all the requests contained in this message. Any text in the message following this line is ignored by MOSIS. All requests (except the "END" request) will be answered by MOSIS—please wait for a reply to one request before sending another request for the same project. Replies will detail what actions MOSIS has taken on the request and, if necessary, the reasons for those actions.

All request and parameter names may be abbreviated, as long as no ambiguities are caused.

D.1. Possible Requests

The MOSIS requests are:

INFORMATION	Request for information on MOSIS procedures.
LIBRARY	Request for information from MOSIS library.
NEW-PROJECT	First message from user to MOSIS regarding new project.
SUBMIT	Submittal of CIF file for CIF-check only.
FABRICATE	Request to fabricate project.
UPDATE	Modification of project parameters.
DELETE-CIF	Deletion of last CIF file submitted for project.
CANCEL-FABRICATE	Request to cancel previously requested fabrication of project.
CANCEL-PROJECT	Total withdrawal of project.
STATUS	Request for status of project.
REPORT	User report on performance of fabricated devices.
ATTENTION	Request to bring to the attention of the MOSIS staff some special message or project requirement.
END	Termination of all requests in message.

D.2. Parameters for the Requests

The parameters and their format are (alphabetically):

ACCOUNT <1 line> Identification of account to be charged for project.

AFFILIATION <1 line> Name of designers' affiliated organization.

ATTENTION <Any number of lines to next parameter or end of message> Requests to bring to the attention of the MOSIS staff some special message or project requirement. May be abbreviated as ATTN.

Note: ATTENTION may be either a REQUEST or a parameter of other requests.)

BOND-SAME-AS <1 line> Specifies need for bonding to duplicate that of an earlier project. User may supply either Project ID or Fab-ID of project to be duplicated.

BYTE-LIMIT <Number> Limits number of bytes in body of message(s) that MOSIS sends back to users requesting information or library file(s).

CIF <any number of lines following, to end of message or to next line starting with "REQUEST:".> The project design.

Note: The keyword "CIF:" has no arguments but is followed on the next and subsequent lines by the project design itself.

Note also that the CIF design must be the last item in the request. Lines following the CIF design, but which do not begin with "REQUEST:", will be considered part of the CIF design (e.g., within the SUBMIT request, if "ATTENTION: <text>" is placed following the CIF text, it will be considered part of the CIF so that the request will not be manually processed).

It is highly recommended that the CIF be explicitly terminated by another request (e.g., REQUEST: END) rather than implicitely by the end of the message.

CIF-CHECKSUM Set of numbers computed for CIF file or fragment to help determine integrity of received file or fragment. See Section G.

CIF-FRAGMENT Fragment of CIF file for project. See Section F.2.

CIF-FTP-PATH List of parameters needed to FTP CIF file to MOSIS. Alternative to CIF parameter. See Section G.

COMMENT <Any number of lines to next parameter specification> Text totally ignored by MOSIS, to be used by designer for any purpose.

DESCRIPTION <Any number of lines> Relatively long description of project.

D-NAME <1 line> Name of MOSIS user submitting the project.

D-PASSWORD <1 line> Password given to this user (D-NAME) to authenticate new project requests sent to MOSIS.

ID <Number> Unique identification of project assigned by MOSIS.

LAMBDA <Number> Value of lambda that applies to this CIF file. Microns assumed, but may be specified in mils, e.g., ".08 mils". Lambda is one half the minimum feature size, and it must be provided even if the design system does not use lambda internally.

LINE-LIMIT <Number> Limits number of lines in body of message(s) that MOSIS sends back to users requesting information or library file(s).

MAX-LAMBDA <Number> Maximum value of lambda to which design may be scaled, in microns (or mils if so stated; see LAMBDA). If not specified, then MAX-LAMBDA = LAMBDA is used and no scaling up of project will take place. Scaling applies only to custom frame projects.

MAILING ADDRESS

<Any number of lines> Address for MOSIS to send packaged parts and correspondence. Should be in EXACT form for shipping label and should particularly include the actual designer's name and street address of organization (including MAIL-STOP, etc.). DO NOT USE Post Office box numbers; the overnight courier will not accept them.

Warning: Do not include ATTN: or ATTENTION: at the beginning of a line in MAILING-ADDRESS or MOSIS will interpret it as ATTENTION parameter.

MIN-LAMBDA <Number> Minimum value of lambda to which design may be scaled, in microns (or mils if so stated; see LAMBDA). If not specified then MIN-LAMBDA = LAMBDA is used and no scaling down of project will take place. Scaling applies only to custom frame projects.

NET-ADDRESS <username>@<sitename> {,<username>@<sitename>}*, 1 line.

Note: MOSIS will send replies to requests to above net addresses. It is very important that the address(es) be kept current throughout the lifetime of the project. See the Section I for information regarding Internet and Telemail addresses.

PADS <Number> Number of pads to be bonded for project. If this parameter is left unspecified, all boxes on the glass layer will be bonded. Pads value of 0 will produce an unbonded, unpackaged chip. This parameter should not be supplied for a standard frame project.

PHONE <1 line> Telephone number(s) where user(s) can be reached.

P-NAME <1 line> Short name for project, e.g., ADDER or SHIFTER.

P-PASSWORD <1 line> Arbitrary password assigned to project by user in NEW-PROJECT request.

REPORT <Any number of lines, however, this parameter must be the last one before next "REQUEST:" or end of message> User report to MOSIS on performance of fabricated project.

SIZE <X dimension> x <Y dimension> Size of project in microns (or in mils if so stated; e.g., "300 x 500 mils"). Required before CIF check for custom frame projects only. See Section H.1.2.

SPECIAL-HANDLING
<Any number of lines> Specifies special size and bonding requests.

STD-FRAME <1 line> Name of standard pad frame, i.e., one of several bonding pad placements for which MOSIS is able to offer automatic wire-bonding.

TECHNOLOGY <1 line> Technology required for project.

TOPIC <1 line> Name of information topic desired. Note: Requesting TOPIC: TOPICS will retrieve a list of all available information topics.

D.3. Relationship of Parameters to Requests

Each project must be initiated by the NEW-PROJECT request. The FABRICATE message must be issued in order to fabricate a project. These are the only mandatory messages. All other messages are optional. The following table shows the relationships between the requests and the parameters. Note that parameters for the messages are either mandatory or optional.

REQUEST	MANDATORY	OPTIONAL
INFORMATION	TOPIC	COMMENT
		ATTENTION
		BYTE-LIMIT
		LINE-LIMIT
LIBRARY	TOPIC	COMMENT
		ATTENTION
		BYTE-LIMIT
		LINE-LIMIT
NEW-PROJECT	D-NAME(+ *)	TECHNOLOGY
	AFFILIATION(+ *)	LAMBDA
	ACCOUNT(+ *)	MIN-LAMBDA
	D-PASSWORD(+ *)	MAX-LAMBDA
	NET-ADDRESS	SIZE
	MAILING-ADDRESS(*)	PADS
	P-NAME	COMMENT
	P-PASSWORD(*)	ATTENTION
	DESCRIPTION	PHONE
		SPECIAL-HANDLING
		BOND-SAME-AS
		STD-FRAME

Note: The parameters marked " + " are those which must match exactly the values in the access tables of MOSIS, which are not communicated via the net messages described here. The parameters marked "*" are those which cannot be changed through messages during the lifetime of the project.

REQUEST	MANDATORY	OPTIONAL
SUBMIT	ID	P-NAME
	P-PASSWORD	DESCRIPTION
		NET-ADDRESS
		PHONE
		TECHNOLOGY
		LAMBDA
		MIN-LAMBDA
		MAX-LAMBDA
		SIZE
		PADS
		CIF
		CIF-FRAGMENT
		CIF-FTP-PATH
		CIF-CHECKSUM
		COMMENT
		ATTENTION
		SPECIAL-HANDLING
		BOND-SAME-AS
		STD-FRAME
FABRICATE	ID	P-NAME
	P-PASSWORD	DESCRIPTION
		NET-ADDRESS
		PHONE
		TECHNOLOGY
		LAMBDA
		MIN-LAMBDA
		MAX-LAMBDA
		SIZE
		CIF
		CIF-FRAGMENT
		CIF-FTP-PATH
		PADS
		CIF-CHECKSUM
		COMMENT
		ATTENTION
		SPECIAL-HANDLING
		BOND-SAME-AS
		STD-FRAME

Note: Fabrication cannot be performed unless LAMBDA, TECHNOLOGY, CIF, and either SIZE or STD-FRAME are already specified. The same parameters are also required for CIF-CHECK.

REQUEST	MANDATORY	OPTIONAL
UPDATE	ID	P-NAME
	P-PASSWORD	DESCRIPTION
		NET-ADDRESS
		PHONE
		LAMBDA
		MIN-LAMBDA
		MAX-LAMBDA
		PADS
		COMMENT
		ATTENTION
		SPECIAL-HANDLING
		BOND-SAME-AS
		STD-FRAME
DELETE-CIF	ID	COMMENT
	P-PASSWORD	ATTENTION
CANCEL-FABRICATE	ID	COMMENT
	P-PASSWORD	ATTENTION
CANCEL-PROJECT	ID	COMMENT
	P-PASSWORD	ATTENTION
STATUS	ID	COMMENT
	P-PASSWORD	ATTENTION
REPORT	ID	COMMENT
	P-PASSWORD	ATTENTION
		P-NAME
		FAB-ID
ATTENTION	ID	<< The ID and the password of
	P-PASSWORD	<< the project must be included
		<< only in project-specific
		<< ATTENTION requests.

END

If any of the mandatory parameters are not included, the *entire* request is rejected. When a parameter is given to MOSIS, it replaces any previous value of it. This does not apply to the D-NAME, AFFILIATION, ACCOUNT, D- PASSWORD, P-PASSWORD, and the ID.

(E) More about MOSIS Messages

All portions of requests are case-independent. No control codes other than <CR>, <LF>, <TAB>, or ↑L should be used. No line should begin with "XXX:" unless "XXX" is a keyword as described above (i.e., a "REQUEST" or a parameter). It is recommended that the request messages include in the SUBJECT field the type of request and the name of the project; for example: "Subject: SUBMIT ADDER".

With one exception, MOSIS will send all responses concerning a project to the net address(es) specified for the project in the NEW-PROJECT request (or an updated address(es) sent to MOSIS by the user at a later date). The exception occurs when there is any problem with the NET-ADDRESS parameter (e.g., it is omitted) or when an ID given by the user is not valid (e.g., does not exist or is not accompanied by the proper P-PASSWORD). In this case MOSIS directs the responses to the SENDER of the request. The SENDER is determined from the first parameter in the following list that also appears in the message before the first MOSIS request: REPLY-TO, SENDER, FROM.

(F) Submittal Procedures

The standard procedure for submitting projects to MOSIS for fabrication consists of three steps:

1. Sending the NEW-PROJECT request and receiving a project ID from MOSIS.
2. Submitting the CIF file for the project using the SUBMIT request containing the MOSIS ID.
3. Requesting the fabrication of the already submitted project using the FABRICATE request containing (again) the MOSIS ID.

These requests can only be issued after the designer has been authorized as a MOSIS user. It is possible to combine steps (2) and (3) above or even (1), (2), and (3) above into a single step. However, in certain situations this procedure cannot be used. The following are descriptions of 1-step and N-step submittal procedures.

F.1. The 1-step Submittal Procedure

This procedure is useful to users who need to expedite the submittal procedure. The 1-step procedure consists of a single message which contains the NEW-PROJECT request *followed* by the FABRICATE request. It uses an asterisk "*" for the project ID. Only the requests contained in this message may use the "*" as the ID for this project. All further requests regarding this project must include the real ID as assigned by MOSIS.

The following is an example of the 1-step submittal:

```
Request:            NEW-PROJECT
D-name:             POOH
Affiliation:        NAVY
Account:            VLSI
D-password:         honey
Net-Address:        Pooh@Navy
Mailing-Addr:       Dr. W. T. Pooh
                    US Navy
                    Anapolis, Md. 23456
P-name:             MULTIPLY 16x20
P-Password:         TIMBAK
Description:        This is a super fast 16x20 bit
                    multiplier for 1's compliment
                    arithmetics, using 2-bit at a
                    time...
Technology:         NMOS/MC
Lambda:             2.5
Pads:               39

Request:            FABRICATE
ID:
P-Password:         TIMBAK
SIZE:               1850 x 3200
CIF:
                    (LAP281B  --- VFFT.CIF);
                    (symbol VFFT);
                    DS 1 250 10;
                    L ND;
                    W 20 960,-50 960,100;
                    B 60 500 1030,80;
                    ......
                    ......
                    E
Request:            END

---
```

F.2. The N-step Submittal Procedure

Some MOSIS users' mail systems do not allow them to send long messages. This causes difficulties in the submission of large CIF files, but not in sending other messages.

These users may use the following procedure:

1. Issue a NEW-PROJECT request and wait for the MOSIS project ID to be assigned by MOSIS.

2. Divide the original CIF file into N small fragments, such that each fragment is small enough to be handled in a single message. Fragment the CIF on both line and command boundaries.

3. Send N messages to MOSIS, each with a fragment, using the SUBMIT request and the CIF-FRAGMENT parameter as described below.

4. After all of the fragments are accepted by MOSIS and the CIF is found valid, issue the FABRICATE request.

Each SUBMIT request should include the same parameters as in the standard procedure except that, instead of the parameter CIF, the parameter CIF-FRAGMENT should be used. The line with this parameter should look like "CIF-FRAGMENT: K/N", where N is the total number of fragments in the CIF file for this project and K is the number of this fragment. The CIF commands should start on the next line after the CIF-FRAGMENT.

The acceptance of each of the fragments will be acknowledged. Only the acceptance of the last one (with N/N) will trigger the automatic CIF check. Only after submitting the last fragment may the FABRICATE request be issued.

The DELETE-CIF request may be used at any time to terminate the submittal of CIF fragments. This is useful when sudden revisions to a project are necessary.

AN IMPORTANT NOTE ON SUBMITTING CIF:

Any submission of CIF is terminated either explicitly, by the next request (typically: "REQUEST: END"), or implicitly, when the end of the message is reached. The latter termination typically results in the message trailer (e.g., "------" of SNDMSG) being appended to the end of the CIF. This addition is not harmful after the CIF "E" command which terminates the CIF file; however, such trailer may be harmful at the end of CIF-FRAGMENTS which may be in arbitrary positions in the middle of a CIF file. Therefore, all CIF submissions (especially when using CIF-FRAGMENT) should be explicitly terminated by the next request, i.e., "REQUEST: END".

(G) CIF Information

G.1. The CIF-CHECKSUM Option for SUBMIT and FABRICATE

The CIF-CHECKSUM option is intended to deal with situations similar to those in which CIF files are created on one computing system (e.g., UNIX), then transferred (e.g., via a local net or a mag-tape) to another system (e.g., TOPS-20) for transmission to MOSIS in network messages. In these situations the CIF-CHECKSUM option should be computed by the originating system (UNIX, in this example) on the entire CIF file (or each CIF fragment, if the file must be fragmented for submittal to MOSIS).

In such situations the CIF files may undergo several trivial modifications, such as replacing EOLs or <CR>s by <CR><LF>s, addition/deletion of nulls and of trailing spaces, conversion of TABs into SPACEs and addition of spaces/<CR>s at either end of the file. The CIF-Checksum is expected to be insensitive to these trivial transformations.

The CIF-CHECKSUM refers to the CIF in the same message, whether it is an entire CIF file, a single CIF-FRAGMENT, or a CIF-FTP-PATH.

The CIF checksum option may be used in a SUBMIT or FABRICATE request, whenever the sender of CIF files or fragments desires. It is never mandatory. If the checksum is given, MOSIS will compute one for the CIF file or fragment and compare the two. A mismatch between a computed and a given checksum is reported to the sender, and the CIF file or fragment is rejected as invalid. If a CIF fragment is rejected as invalid, the CIF sent so far is still intact; only the rejected fragment needs to be sent again.

G.2. Computation of the CIF-CHECKSUM

The following is the definition of this CIF-CHECKSUM.

- The checksum is defined only for files consisting of ASCII characters. All bytes are treated as 7-bit ASCII codes.
- Null characters (ASCII-0) are ignored.
- All characters (bytes) are assigned values which are their 7-bit ASCII codes (e.g., their ASCII code modulo 128) if these values are above 32-decimal (40-octal), the SPACE byte.
- If this.value is not above 32, then the byte is considered to be a SEPARATOR. All sequences of consecutive separators are given one value of 32 and counted as a single character regardless of their length.
- The checksum (CKSUM) is the sum of the values (as defined above) of all the bytes in the file. It is computed as if there are separators at both the beginning and end of the file.

- The character count (NCHAR) is the number of non-separator characters plus the number of separator-sequences (including the implied ones at the beginning and end of the file).

- The checksum field is a string of decimal digits expressing the CKSUM (as defined above) and NCHAR, separated by space(s). These numbers must always be positive.

- Leading and trailing spaces, and leading zeros, are allowed to be in this field, and are ignored for comparison purposes.

The actual computation of the CKSUM is as follows:

```
1.  *  Set PREV!CHR!SEP to TRUE,
    *  Assign the value 32(decimal) to CKSUM,
    *  Assign the value 1 to NCHAR.

2. For each byte from the file:
       IF it is a null then ignore it, ELSE
       Assign its 7-bit-ASCII value to THIS!BYTE,
       IF THIS!BYTE>32
       THEN
         * Add THIS!BYTE to CKSUM,
         * Add 1 to NCHAR,
         * Set PREV!CHR!SEP to FALSE.
       ELSE
         * IF PREV!CHR!SEP
           THEN ignore it,
           ELSE
             * Add 32 to CKSUM,
             * Add 1 to NCHAR,
             * Set PREV!CHR!SEP to TRUE.

3. IF PREV!CHR!SEP = FALSE
   THEN
     * Add 32 to CKSUM,
     * Add 1 to NCHAR.

4. Output the value of CKSUM and NCHAR.
```

Programs which compute the checksum values are available through MOSIS via the INFORMATION request with the following TOPIC values:

TOPIC:	Program source language
CKSUM1.MAC	TOPS-20 MACRO assembler
CKSUM1.C	TOPS-20 C compiler (readily modified for other operating systems)

G.3. The CIF-FTP-PATH Option

MOSIS can accept CIF for projects by using FTP to retrieve them. The FTP-path for the CIF is specified by a one-line parameter of the form:

CIF-FTP-PATH: /hostname/username/password/account/filename

where the character "/" may be replaced by any printing character that is to be used to delimit the parameter fields, and where

hostname	is the name of an Internet host known to ISI,
username	is the name of a user on that host who can login via FTP (or if no user name is needed, this field may be left empty),
password	is the literal password needed to do the FTP login (this field may be left empty if not required),
account	is the account under which the user needs to login via FTP (this field may be left empty if not required),
filename	is the name of the file containing the CIF text.

This line may be included in place of the CIF: or CIF-FRAGMENT: line of a SUBMIT or FABRICATE request. The following is an example of the use of this line in a FABRICATE request:

```
REQUEST:          FABRICATE
ID:               67890
P-P:              SAY-WHAT?
CIF-FTP-PATH:     !ISIF!VLSI-TEST!TEST!!TEST.CIF
REQUEST:          END
```

NOTE: The user chose the field delimiter to be the character "!". No FTP account parameter is, but the delimiters for the account field are retained.

MOSIS will make periodic transfer attempts. The desired file must be unprotected. MOSIS will notify the user either when the transfer is successful (this message will include the CIF-CHECKSUM computed for the file), or if the transfer attempts fail.

If a CIF-checksum is provided with this CIF-FTP-Path, then it is stored for comparison by MOSIS after the CIF is retrieved. If FTP retrieval of CIF-fragments is necessary, the user may obtain instructions from MOSIS by sending an ATTENTION request. The FTP retrieval service is available only to hosts implementing DARPA's IP/TCP/FTP, and is not available through Telemail.

(H) Project Requirements and Special Requests

H.1. Packaging and Bonding

MOSIS uses both 28–pin, 40–pin, and 64–pin DIPs, and 84–pin grid arrays. Packaging in 64–pin and 84–pin packages may take longer than packaging in 28–pin and 40–pin packages. A project may use either a MOSIS standard project frame (as described in the Section H.1.2) or a custom frame designed by the user (see Section H.1.3). Packaging in custom frames may take longer than packaging in standard frames.

The use of standard library bonding pads is highly recommended. Instructors should prevent creative bonding by students.

H.1.1. Standard project frames

The MOSIS service offers standard frames as an alternative to custom project frames where every project pad layout is unique. A standard project frame is a rectangular area of a fixed size and with a fixed set of bonding pad locations around the periphery of the rectangle. The circuitry in the remainder of the frame, the routing of pad connections, and the choice of pad types at each of the fixed locations are up to the user.

The use of standard frames has numerous advantages over custom frames to both the MOSIS service and the user community:

1. The bonding of projects in standard frames is always the same for a given frame; therefore, packaging is both faster and more reliable.

2. Designers using standard frames determine their own package pin–out.

3. The future MOSIS pad routing service will support automatic pad routing to the standard frame chosen.

4. The future MOSIS functional testing service will provide probe cards for the standard frames; projects in custom frames will have to create their own private probe cards.

The Frames

Standard frames are available in six sizes and four different pad counts, for a total of eleven standard frames as listed in the table below. The matrix shows the official "name" assigned to each frame offered. Each frame size represents the total area available to the user for project geometry; all scribe lanes, markings, and other manufacturing and processing details are added by MOSIS outside this frame.

Frame (microns)	Package 28	40	64	84
7900 x 9200	--	--	64P79X92	84P79X92
6900 x 6800	--	40P69X68	64P69X68	84P69X68
4600 x 6800	--	40P46X68	64P46X68	--
4600 x 3400	28P46X34	40P46X34	--	--
2300 x 3400	28P23X34	--	--	--
1900 x 2558	--	ParcBasic	--	--

The 28–and 40–pin packages are both 0.6" wide DIPs; the 64–pin package is a 0.9" DIP; the 84–pin package is a pin grid array.

The pad layout of each standard frame, other than "ParcBasic", has one–fourth of the pads evenly spaced along each side. "ParcBasic"[1] is taken directly from the Basic Design Frame that was conceived at Xerox PARC (see "The Design of a Basic Design Frame" by Alan Paeth, available from XeroxPARC); this layout corresponds to the design frame at lambda equals 2.0 microns. The following table characterizes the pad layouts in terms of three parameters; the units are microns.

Pad–to–Edge — the distance from the center of each pad to the adjacent frame boundary. Pad–to–Edge is intended to be sufficient to accommodate the pad itself and a ground bus around the outside; the minimum pad–to–edge value is sufficient to accommodate MOSIS standard library pads.

Pad–to–Pad — the (center to center) distance between pads along an edge. The minimum value is 256 microns (for the next round of larger packages, the spacing will necessarily decrease to about 200 microns or so).

Pad–to–Corner — the distance from the center of the first/last pad on an edge to the corner of the frame. Where there is sufficient room, a minimum corner spacing of 750 microns is maintained.

---

[1] Figure 3 shows three instances of the ParcBasic standard frame.

The first number, pad-to-edge, is the same for all the pads in a frame, but the other two are set separately for each pair of sides. The described orientation has N(orth) corresponding to the +Y direction of the Cartesian coordinate system used in CIF, E(ast) to the +X direction, W(est) to the -X direction, and S(outh) to the -Y direction.

Frame (Name)	Edge	-----N/S----- Pad	Corner	-----E/W----- Pad	Corner
ParcBasic	140	(none)		272	480,174
28P23X34	150	256	382	300	800
28P46X34	150	500	800	300	800
40P46X34	150	300	950	256	548
40P46X68	150	300	950	500	1150
64P46X68	150	256	380	300	1150
40P69X68	200	500	1200	500	1150
64P69X68	200	300	1200	300	1150
84P69X68	200	300	450	300	400
64P79X92	250	400	950	500	850
84P79X92	250	300	950	375	850

These numbers are reflected in the CIF and LIST files described below.

All the pads of a standard frame project are bonded to the package pads in a fixed pattern. ParcBasic has its sixteen pads bonded into a 40- pin DIP according to the drawing in the design paper. The other DIP frames number pads beginning at #1, which is at, or immediately above, the center of the E(ast) or +X side, and proceeding counterclockwise around the frame. The pin grid array frames locate pad #1 at the E(ast) end of the N(orth) side and proceed counterclockwise, terminating at the N(orth) end of the E(ast) side. The CIF files distributed by MOSIS highlight pin #1.

Note that MOSIS will connect package pin #1 to both the silicon substrate and project pad #1. The preceding statement does not apply to CMOS/SOS projects.

H.1.2. Procedures for using standard frames

To use a standard frame, the user must:

1. acquire from MOSIS (or derive from the table above) a description of the frame(s) of interest;

2. integrate that description into a design (i.e., put the pads at the right places);

3. inform MOSIS of the standard frame that is associated with a submitted project.

Standard frame descriptions are available from MOSIS in two forms: (1) a CIF file (framename.CIF) that draws the bonding pads and the frame outline and highlights pad #1, and (2) a text file (framename.LIST) that lists the bonding pad centers, one per line. These files may be obtained via an information request to MOSIS. For example, the files for 28P23X34 are obtained with the following request:

```
REQUEST:    INFO
TOPIC:      28P23X34.CIF
TOPIC:      28P23X34.LIST
```

When submitting to MOSIS a project using a standard frame, the parameter "STD–FRAME" is mandatory; it may be included in any of the NEW–PROJECT, SUBMIT, FABRICATE, or UPDATE requests. The argument to STD–FRAME is the frame name, for example:

```
STD–FRAME: 28P23X34
```

A project in a standard frame cannot specify a "PADS" parameter and need not specify a "SIZE" parameter. In addition, the "MIN–LAMBDA" and "MAX–LAMBDA" parameters, which are used to control the limits of project scaling, are irrelevant since standard frame projects are never scaled.

The MOSIS CIF check for a standard frame project will include a check that the project is not larger than the size of the declared frame and that ALL the pads of the frame are indeed present. The minimum acceptable pad geometry is a 90 x 90 micron glass cut box over a 100 x 100 micron metal box, centered at the designated pad location. A pad may be larger and/or off–center, provided that it completely covers the minimum geometry.

Project geometry may touch the frame boundary; MOSIS will provide appropriate separation between adjacent frames. However, when a project is smaller than the frame size, MOSIS will figure the best fit match between the actual project pads and those expected for the frame.

There is no requirement anywhere that a project be specified in terms of an absolute CIF origin. All sizes and positions are relative to an arbitrary project origin.

Following is a sample CIF file:

```
( 28P23X34.CIF -- MOSIS standard frame with 28 pads
  (7 per side) in a 2300 x 3400 micron project frame.

        Side:   2300    3400
                 N/S     E/W
                ----    ----
  Pad-to-Pad:    256     300
  Pad-to-Corner: 382     800
  Pad-to-Edge:       150
);
DS 1 100/1;   (one minimum bonding pad, center at 0,0);
L NM; B 100 100 0 0;
L NG; B  90  90 0 0;
DF;

DS 3 100/1;   (pad #1, marked for visibility);
C 1;
L NX; W 4 -35 10 5 10; W 4 -35 -10 5 -10;
      W 4 -25 20 -25 -20; W 4 -5 20 -5 -20;
      W 4 15 30 25 30 25 -30; W 4 15 -30 35 -30;
DF;

DS 2 100/1;
L NX; B 2300 3400 1150 1700; (The frame,
                              from 0,0 to 2300,3400);
(  east side --  );
C 3 T 2150 1700; (pin #1 -- the substrate connection);
C 1 T 2150 2000; (pin #2);
C 1 T 2150 2300; (pin #3);
C 1 T 2150 2600; (pin #4);
(  north side --  );
C 1 T 1918 3250; (pin #5);
C 1 T 1662 3250; (pin #6);
C 1 T 1406 3250; (pin #7);
C 1 T 1150 3250; (pin #8);
C 1 T  894 3250; (pin #9);
C 1 T  638 3250; (pin #10);
C 1 T  382 3250; (pin #11);
(  west side --  );
C 1 T  150 2600; (pin #12);
C 1 T  150 2300; (pin #13);
C 1 T  150 2000; (pin #14);
C 1 T  150 1700; (pin #15);
C 1 T  150 1400; (pin #16);
C 1 T  150 1100; (pin #17);
C 1 T  150  800; (pin #18);
(  south side --  );
C 1 T  382  150; (pin #19);
C 1 T  638  150; (pin #20);
C 1 T  894  150; (pin #21);
C 1 T 1150  150; (pin #22);
C 1 T 1406  150; (pin #23);
C 1 T 1662  150; (pin #24);
C 1 T 1918  150; (pin #26);
(  east side again --  );
C 1 T 2150  800; (pin #26);
C 1 T 2150 1100; (pin #27);
C 1 T 2150 1400; (pin #28);
DF;

C 2;
E
```

Following is a sample LIST file:

```
<<<< 28P23X34.LIST >>>>

2150, 1700  -- pin #1 -- the substrate connection
2150, 2000  -- pin #2
2150, 2300  -- pin #3
2150, 2600  -- pin #4

1918, 3250  -- pin #5
1662, 3250  -- pin #6
1406, 3250  -- pin #7
1150, 3250  -- pin #8
 894, 3250  -- pin #9
 638, 3250  -- pin #10
 382, 3250  -- pin #11

 150, 2600  -- pin #12
 150, 2300  -- pin #13
 150, 2000  -- pin #14
 150, 1700  -- pin #15
 150, 1400  -- pin #16
 150, 1100  -- pin #17
 150,  800  -- pin #18

 382,  150  -- pin #19
 638,  150  -- pin #20
 894,  150  -- pin #21
1150,  150  -- pin #22
1406,  150  -- pin #23
1662,  150  -- pin #24
1918,  150  -- pin #25

2150,  800  -- pin #26
2150, 1100  -- pin #27
2150, 1400  -- pin #28
```

H.1.3. Custom project frames

A project is presumed to use a custom frame if it has not been declared to use a standard frame (via the STD-FRAME parameter). For custom frame projects, MOSIS creates unique individual bonding maps reflecting the actual pad layout in the CIF file.

The BOND-SAME-AS parameter may be used to specify the need for bonding of one project to duplicate that of an earlier project (see Section D.2).

MOSIS requires adherence to two bonding rules not included in "Introduction to VLSI Systems" by Mead and Conway. Failure to comply with these rules may be fatal to device performance. They are:

1. Projects must use pads (glass cuts) not less than 90microns (3.5 mil) square, with center-to-center spacing of not less than 200microns (8.0 mil). Note that these are absolute sizes, independent of the value of lambda. Glass cuts must be easily identified by an operator using a low-power (low-quality) microscope. Cuts at random places over metal strips may not be noticed by the bonding staff.

2. Pads for bonding should be placed along the edges of the project (preferably in a uniform distribution) and not inside the project. This simplifies the bonding task significantly. There should be no more than N/4 pads per side, and no more than a total of N-1 pads, where N is the package lead count. For MOSIS standard packages, N is either 28, 40, 64, or 84. It is highly recommended that users leave one pin of the desired package free. This will be very helpful if it becomes necessary to use packages where pin-1 is tied to the body. A project that uses all available pins of one size package will ordinarily be packaged in the next larger size, unless an ATTENTION request is received detailing the need for a specific size.

Complying with these rules is required for proper bonding, given compliance with other bonding rules.

Please refer to the MOSIS design-rule documents for more details regarding bonding pads, especially when 2nd-metal is used. The MOSIS NMOS design rules are described in detail in the INFORMATION document for TOPIC: NMOSDR.

H.2. Project vs. Die Size

A MOSIS die consists of a fixed starting frame plus a payload area that is available for user projects. Small projects are often packed together in a single die, while large projects tend to occupy their own dies. The MOSIS starting frame consists of a frame around the die perimeter plus a horizontal swath across the top of the die to hold die identification markings. The frame, consisting of a half-scribe lane and a metal guard ring, uses 85 microns per side, while the marking swath across the top is 560 microns high. In addition, a minimum spacing of 15 microns is enforced between any two entities, whether guard ring, test strip, or user project(s).

Taken together, this overhead causes the user payload area to be 200 x 300 microns smaller than the die; the MOSIS standard maximum project size of 6900 x 6800 microns is based on this overhead and a die that is 7100 microns square. Any project that is larger than this maximum project size requires an oversize die and is treated as an oversize project. Note that MOSIS will, at its convenience, place a project on a die either "as received" or rotated ninety degrees counterclockwise.

Note: Following sections will consider die size rather than project size; the reader may translate to project size by subtracting the overhead.

H.2.1. Mask manufacturing considerations

MOSIS masks are produced using E-Beam systems (manufactured principally by Perkin-Elmer ETEC and Varian Associates). These systems read pattern files to produce bit maps that are then used to drive the E-Beam in a raster scan operation. Due to bit map size restrictions that apply to operations regularly invoked by MOSIS (e.g., pattern sizing), we are currently limited to dies that are no more than 8192 microns wide (there is no practical limit on die height). MOSIS therefore treats 8192 microns as its maximum die width and turns 'wide' projects on end.

H.2.2. Packaging considerations

A project which is to be packaged and bonded must reside on a die that will fit into the cavity of the intended package. The 28-pin, 40-pin, 64-pin, and 84-pin packages used by MOSIS come in a few standard cavity sizes, the largest of which can accommodate a square die of approximately the following size:

Package	Cavity	Maximum Die Dimension
28-pin	7.75 mm	6.25 to 7.25 mm
40-pin	7.75 mm	6.25 to 7.25 mm
64-pin	10.00 mm	8.50 to 9.50 mm
84-pin	11.00 mm	9.50 to 10.50 mm

The die dimension limit allows for leeway between cavity and die to facilitate the actual die-to-package wire bonding. This leeway is not exact; the cited lower limit is conservative, while the upper is somewhat high. Note that the MOSIS standard die size, 7.1 mm, is near the upper limit for the 40 pin package.

Users with special needs should secure their own packages for MOSIS's use in bonding their projects. Each such case must be negotiated individually to determine whether the MOSIS packager can handle such parts.

H.2.3. Wafer layout and die size selection

Fabricated wafers are diced into individual dies by sawing the wafer through the scribe lanes. Thus the die layout on the wafer must result in a reasonable grid that is amenable to sawing. A general consequence is that each unique die size on a wafer must be allocated a substantial portion of the available real estate. To the extent that a multiplicity of die sizes complicates wafer sawing, it also adds both risk and delay to the packaging process.

The selection of a set of die sizes for any particular MOSIS fabrication run is, and will remain, a human judgment operation that takes into account the set of projects actually submitted, the relative area requirements, the potential wafer layout, and the actual wafer size used by the selected fabricator.

H.2.4. Project vs. die size summary

1. MOSIS cannot fabricate any dies wider than 8192 microns. The smaller dimension of a project must therefore be less than 7980 microns.

2. MOSIS will NOT fabricate any (oversize) project that cannot fit into an appropriate package UNLESS the user either:

    - declares explicitly that he wants unpackaged parts, or

    - *with prior approval*, provides to MOSIS the necessary packages for his project.

Die size and wafer layout considerations may cause some or all oversize projects to be omitted from a particular run. Therefore, while MOSIS will attempt to give timely service to all submitted projects, oversize projects cannot be guaranteed fabrication on the first, or any particular, fabrication run subsequent to their submission.

H.3. Production Parts

MOSIS maintains a list of projects needing production quantities for prototype evaluation and similar purposes. Each of these projects will be fabricated on each subsequent appropriate run until the needed production quantity for the project has been fabricated and delivered, at which time the project will be taken off the list.

Priority in the production of parts from this list will be given to those projects which will be wafer-probe screened (i.e., not requiring packaging for testing).

In order to have a project included on the production-quantity list, the user responsible for the project must send justification for inclusion to the appropriate DARPA or NSF sponsor; additionally, the project must have already been tested to eliminate design errors and to prove feasibility for production use.

The justification must include the MOSIS project ID, the latest Fab-ID, the quantity of parts needed, and a copy of the report which the user has already sent to MOSIS concerning the small-quantity dies which the user has tested.

Anyone receiving parts from the production-quantity list will be expected to provide MOSIS with reports following the testing of parts from each run. A final report concerning the performance of the parts in the intended production environment will be expected within a reasonably short interval following the final delivery of parts.

(I) Netmail Procedures

I.1. Internet Addresses

The NET-ADDRESS parameter for a MOSIS project request (NEW-PROJECT, SUBMIT, FABRICATE, etc.), should follow the syntax for ARPA Internet messages as specified in "Standard for the Format of ARPA Internet Text Messages", by David H. Crocker, RFC 822, NIC 41952, available from the Network Information Center. The following limitations apply:

1. The address parameter must fit on one line of less than 200 characters; address "folding" is not supported.

2. The special characters <CR>, <LF>, and <NUL> may not be part of the address(es), even if part of a quoted string or quoted pair.

For users who are NOT directly connected to the Internet, but are connected to a local net accessible through a host on the Internet, the net-address given must be to a mailbox on the Internet host, rather than on the host within the local net. MOSIS maintains no table associating the local-net name for a host and the particular Internet host handling mail for that site. The correct form of Internet address is idiosyncratic to the site.

I.2. Telemail Addresses

The way to send messages to MOSIS from TELEMAIL is by sending a TELEMAIL message to MOSIS/USCISI. Any NET-ADDRESS parameter (as is needed in any project-related request) must be of the following form:

XXX/YYY <MOSIS.TELEMAIL>

where "XXX/YYY" is the TELEMAIL address to receive replies from MOSIS. For example, the following would be a valid NET-ADDRESS parameter line:

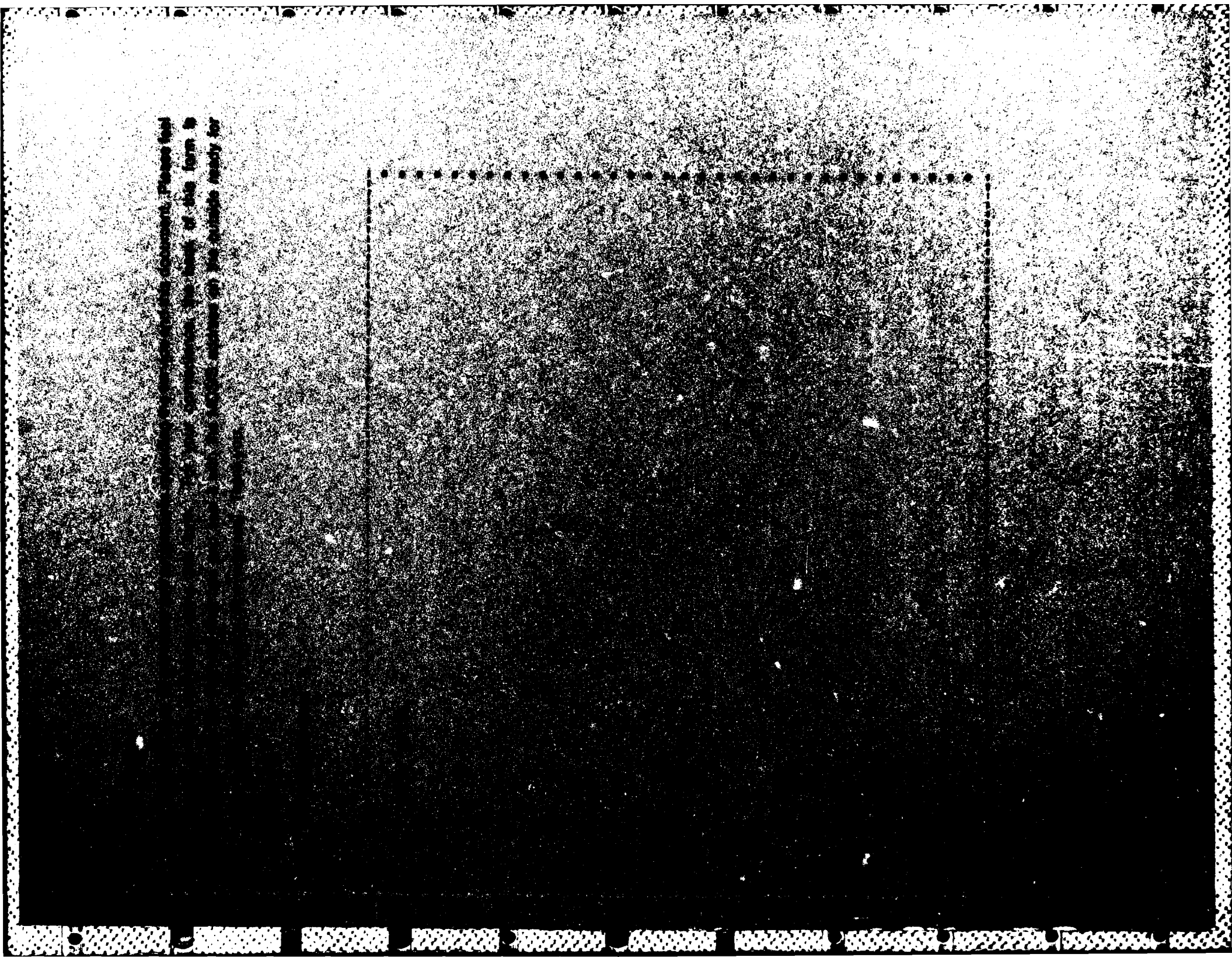
NET-ADDRESS: RICHARDSON/USCISI <MOSIS.TELEMAIL>

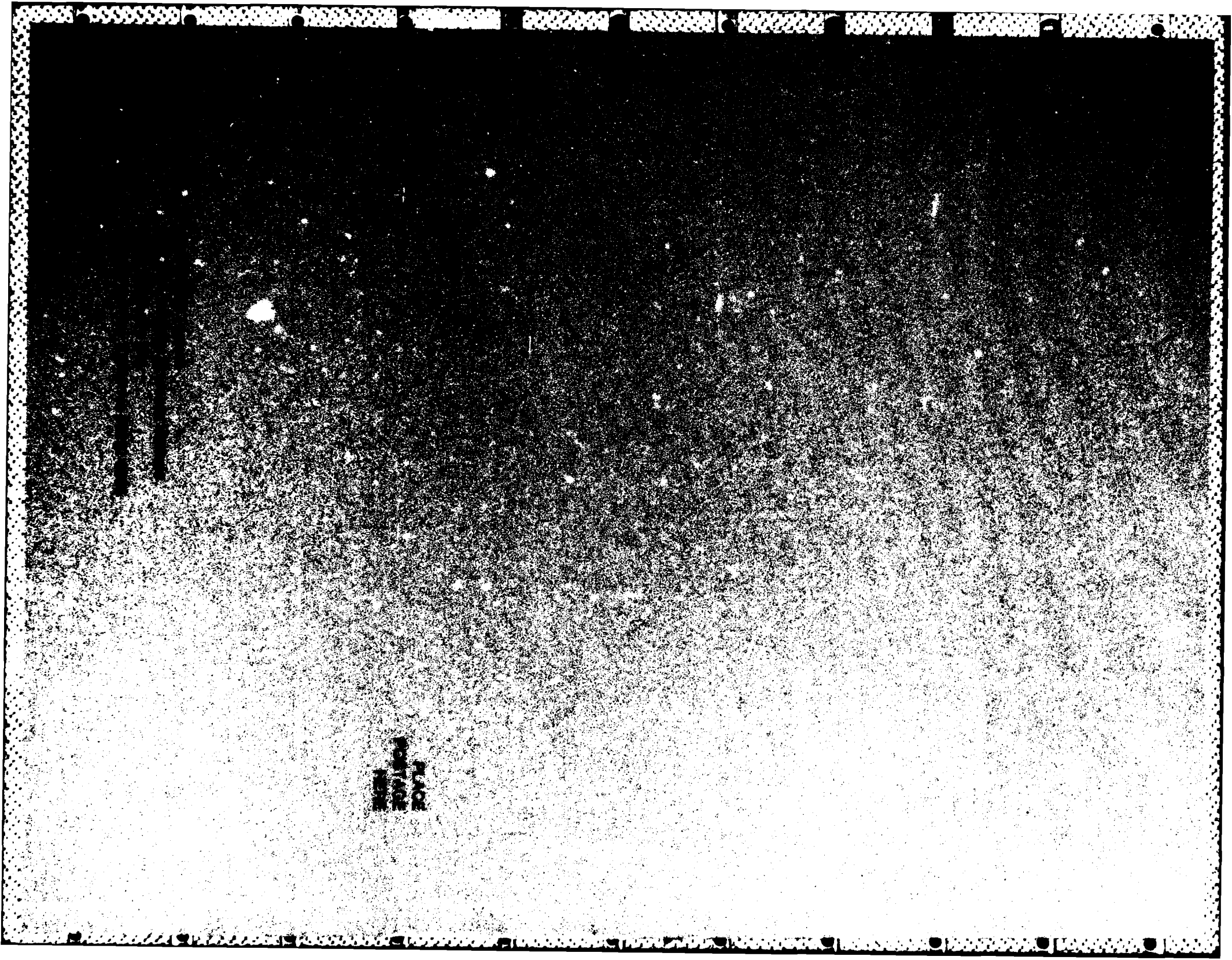
I.3. ARPA Internet Mail Size

With the adoption of new software for the handling of ARPA Internet mail, MOSIS presently must deal with the following limitation on the size of ARPA Internet mail, both incoming and outgoing: no single item of Internet mail having more than about 890,000 characters can be handled, to or from MOSIS.

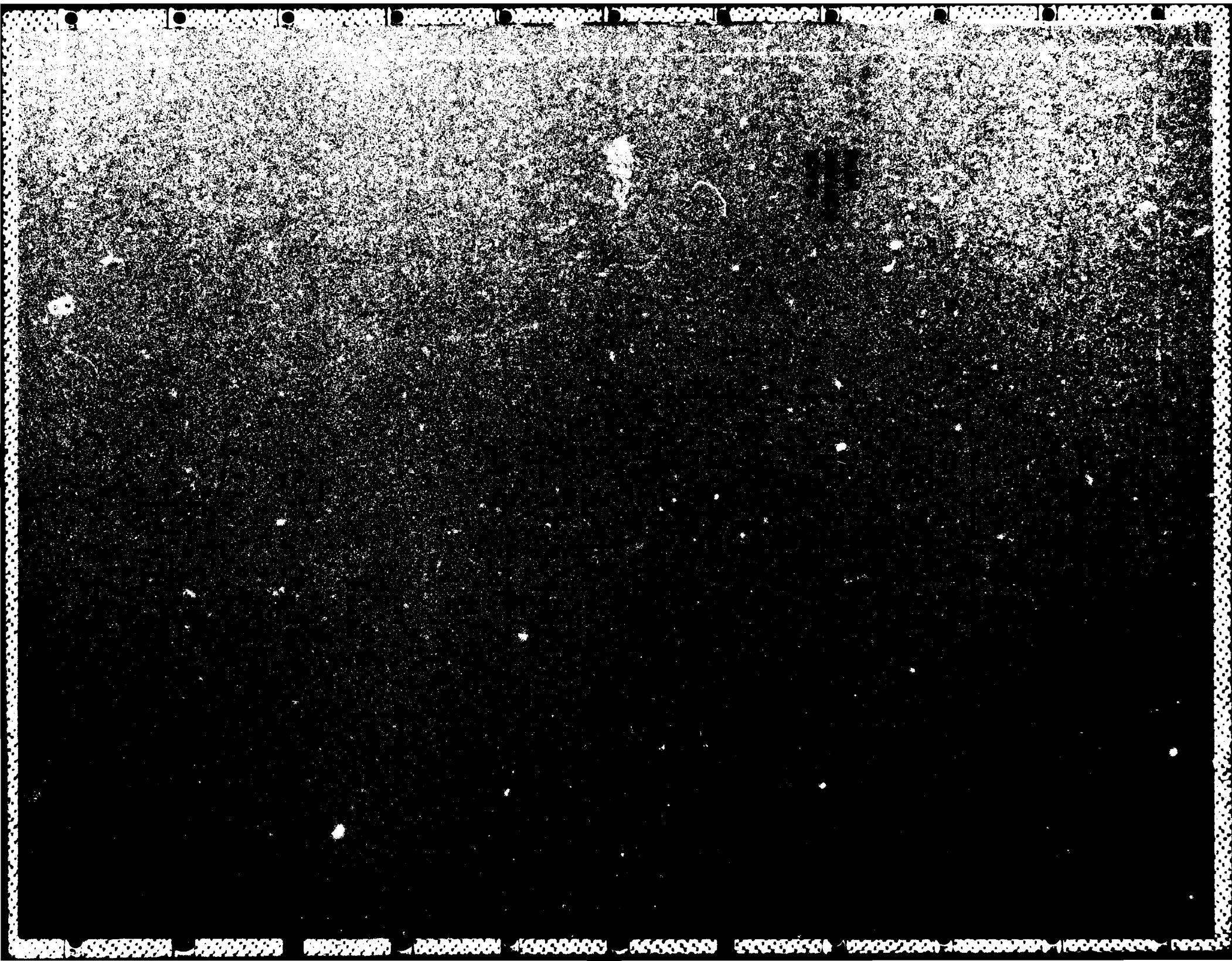
This limitation may eventually be removed, but for the time being, any user having a project CIF of more than about 890,000 characters should submit that project in CIF-fragments of less than 890,000 characters each (including message headers).

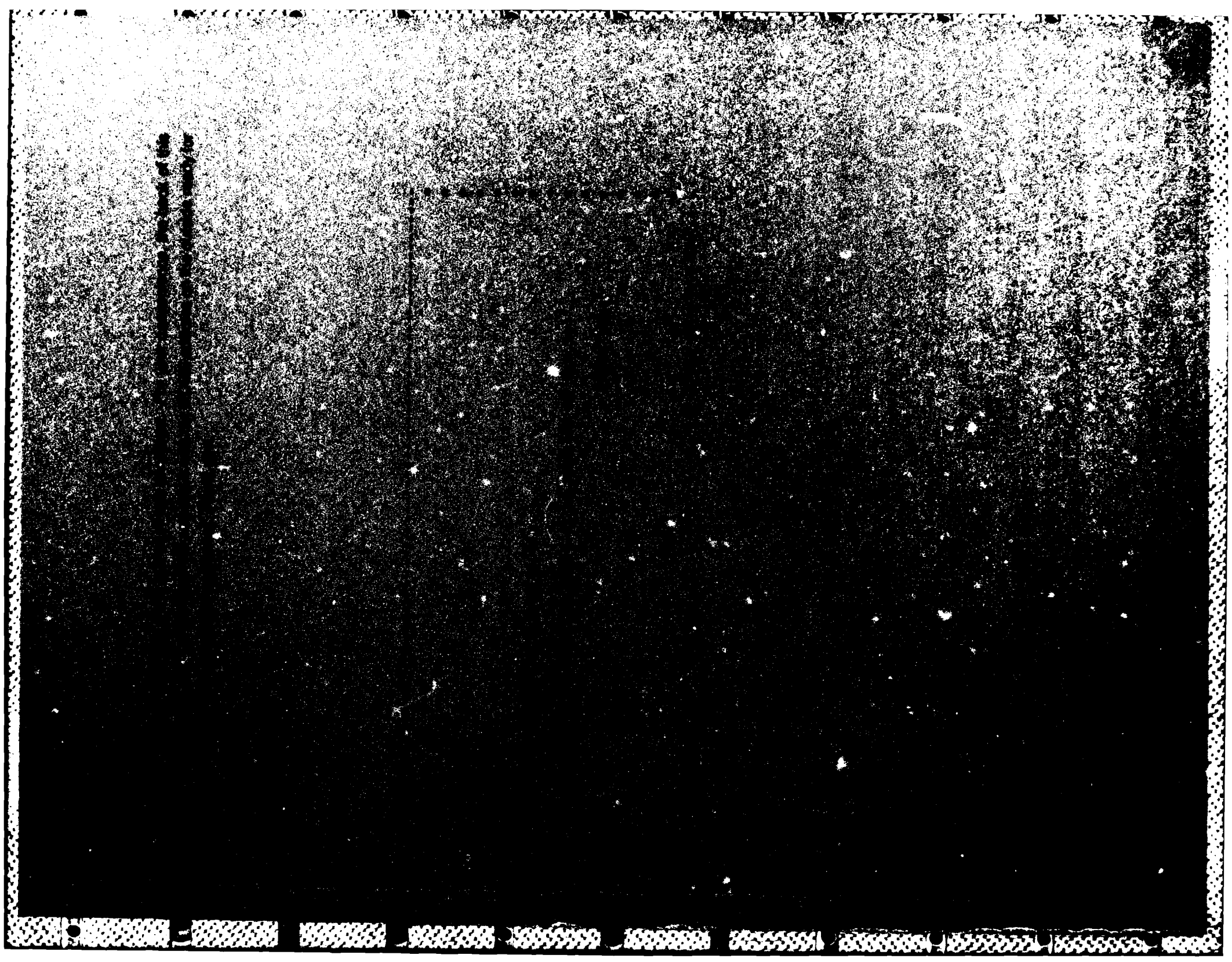
Please note that this limit does NOT apply to the transfer of CIF files via the specification of a CIF-FTP-PATH.

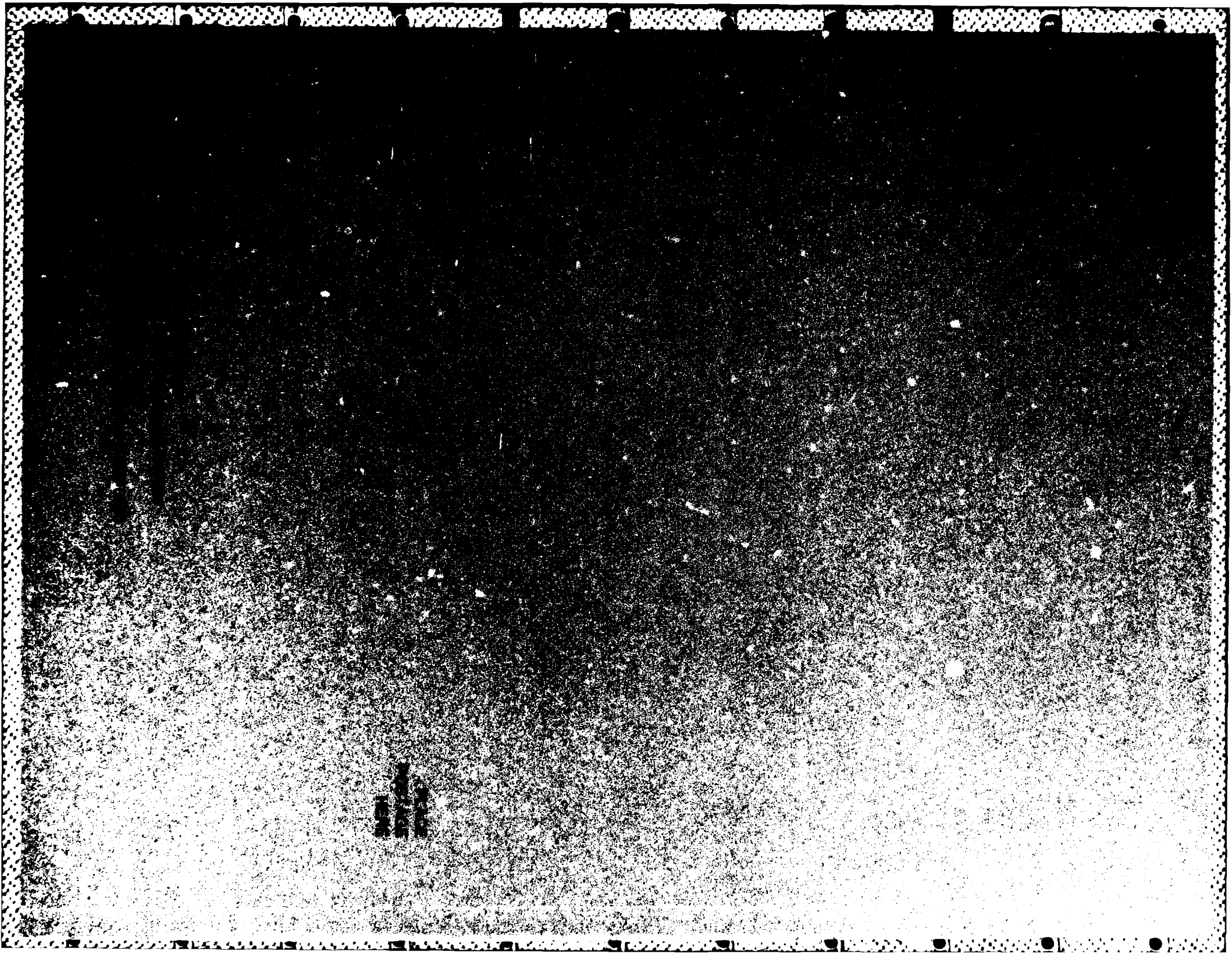




...questions regarding the service and this document. Please feel ... this form. For your convenience, the back of this form is ... and seal it with the MOSIS address on the outside ready for ... Thank you.



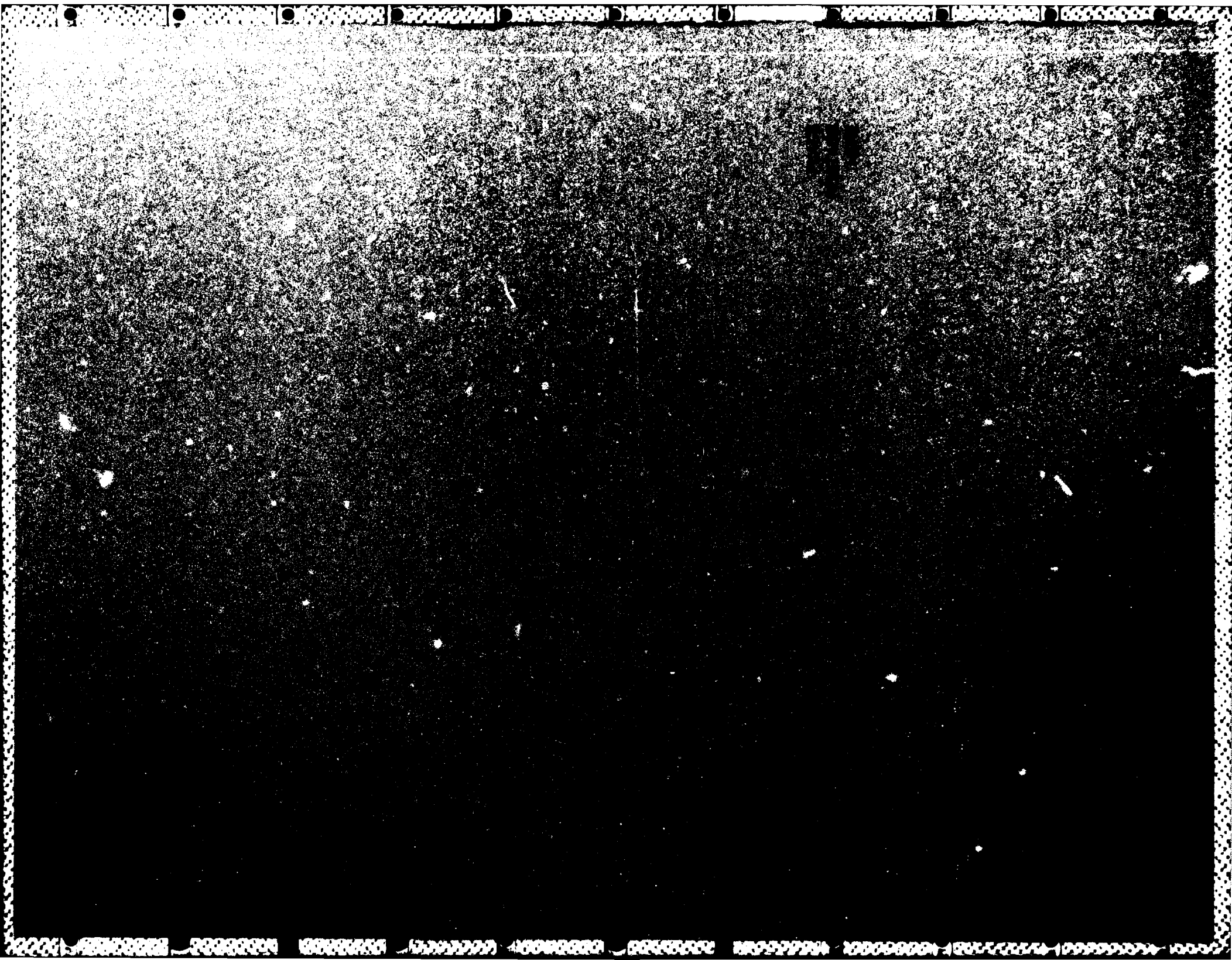




[illegible] this document. For your convenience, the back of this [illegible] the MOSIS address on the outside ready for [illegible]. Thank you.

[illegible]

Thank you.



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